The Influence of Access on the Use of Specialists Health Care in Norway

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Abstract

In the Norwegian health care system equal distribution and access to care regardless of social status, gender, ethnicity and area of living has been raised as an important issue. One of the key strengths of the Norwegian health care system is the equity objective of *equal use for equal need*. This paper studies the extent to which the principle of "equal access" and "equal use for equal need" is maintained in the specialist health care delivery system of Norway. We include three types of specialist health care services: hospital inpatient stay, hospital outpatient visit and private specialist visit. We investigate *inequality in access* with accessibility indices that combine rich information on the capacity of specialist health care and the distance from residence to the hospital and private specialist care. We investigate *inequity in the use* of specialist health care with data from the 2008 Survey of Living Conditions linked with data on access to specialist health care (accessibility indices). We find inequality of access to specialist health care revealing that the capital *Oslo* has the best access to specialist health care and the residents of northern Norway (*Finnmark county*) has the worst access. Moreover, we find inequities in use of *hospital inpatient stay* with respect to *ethnicity* and *education*, in use of *hospital outpatient* visit with respect to *education* and *access to private specialist* and in use of *private specialist visit* with respect to *education, household income* and the *access to private specialists*. We find that the better access to private specialists is, the higher is the probability of visit to a private specialist. Regarding hospital outpatient we find that the better access to private specialists is, the lower is the probability of a visit to hospital outpatient clinic. This suggests that the use of a hospital outpatient visit is a possible substitute for private specialists. We consider this study to be helpful in identifying how equitable specialized health care are distributed and in developing future health policies.

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1. INTRODUCTION

The pursuit of equity of access to health care is a central objective of many health care systems (Goddard and Smith 2001; p. 1149). Several countries state that their aim is a health care system that ensures their citizens' universal and equitable access to good quality health care (Oliver and Mossialos, 2004). In the Norwegian health care system equal distribution and access to care regardless of differences in social status, gender, ethnicity and area of living has been raised as an important issue (Heggestad, 2009). Moreover, the Act on Health Enterprises stipulates that the main goal is to provide good and equitable specialist health care based on need and independent of age, sex, area, economy and ethnic background. However, various studies find that equal access to specialist health care is not fulfilled (Kopperud 2002) and the use of specialist health care in Norway is also determined by easy access and not solely by need (Iversen and Kopperud, 2002; Iversen and Kopperud, 2005; Nerland and Hagen, 2008).

The aim of the present study falls into two parts. First, we are interested in whether the residents living in different municipalities in Norway have equal access to specialized health care irrespective of whether they live very close to a hospital/private specialists or whether they live in a remote area. Thus, this motivates to explore whether the policy statement of equal access in the Norwegian health care system is fulfilled. *Access* to specialized health care in this study is measured as a *distance weighted* form of the simple ratio "*per head specialized health care*" for each municipality and incorporates three elements: (i) the capacity of specialist health care as measured by effective hospital beds, physician man-labor years and contracted private specialists man-labor years, (ii) the distance from the municipality to be served to the municipality providing specialist health care, (iii) a discount function is introduced to place higher weights on capacity offered nearby and contrary low weights to long distanced capacity. Based on these elements we develop accessibility indices as a proxy for access.

Second, adapting an explorative approach, we investigate whether the policy statement about equity in the form of *equal use for equal need* (horizontal equity) is achieved in the Norwegian specialized health care system. We obtain results for three types of specialized health care: hospital inpatient stay, hospital outpatient visit and private specialized visit. In this study horizontal equity exists if use varies according to need as proxied by morbidity variables (*self assessed health* and the suffering of a *chronic illness*). Contrary, there is horizontal inequity if individuals with the same levels of need utilize different amount of specialized health care due to factors that ought not to affect use i.e. access to specialized health care. The analyses are organized as follows: we use the constructed accessibility indices in part 1 as a proxy for access to specialized health care for each municipality. We then merge these indices with data from 2008 Survey of Living Conditions by Statistics Norway, thereby combining individual data with a measurement of access to specialized health care, providing individual data about use, need, and access to specialized care. The determinants of horizontal inequity are analyzed using logistic regression.

This thesis is organized as follows. In section 2 the institutional framework of the study is presented. Here we introduce the Norwegian health care system: the public and private actors, access to specialists health care and finally equity and access regulation. Since the main interest of the thesis is equality and equity, section 3 concentrates on the importance of equity in health care and view some widely used principles of equity. In section 4, a literature review is presented following section 5 describing the aims of the study. In investigating inequality in access we develop accessibility indices presented in section 6. Section 7 describes the data and the statistical method used in investigating of equity. Section 8 presents the results and, finally, section 9 discusses the results and outlines the main conclusions.

2. Norwegian health care system

In the last few decades the Norwegian health system has been going through several reforms, some radical, making use of different approaches in the financing, organizing and provision of services (Johnsen, 2006). New models for financing hospitals, the introduction of the regular GP system and the state ownership of hospitals are some of the recent reforms. Generally, the reforms have been focusing on priorities and patients rights and the responsibility of providing health care services. However, the main vision and goals of equality has been consistent over time (Johnsen, 2006).

The Norwegian health care system is organized in three levels. On the national level, the overall responsibility for the health care rests on the central government. Their main tasks along with Ministry of Health and Care Services are preparation of major reforms, guidelines, responsibility for national policy and income of the lower government levels. On the regional level, four Regional health authorities were established and given the responsibility for providing citizens with specialist health care within their region. Finally, on the local level, represented by the municipalities, has responsibility for primary health care.

In 2002 the state took over ownership of hospitals, until then the county council (19 counties) was responsible for financing, planning and provision of specialized health care. This reform was made up of three strategies (Johnson, 2006). (1) The responsibility was transferred to the central government. (2) Even though the ownership is public, the hospitals are organized as enterprises meaning that they are separate legal entities and not an integral part of the central government. (3) The responsibility of everyday functioning of the enterprises lies apparently in the hands of the general manager and the executive board. Even though the state delegates the responsibility it persists in controlling the health care services through guidelines, instructions, the financing system and so forth.

The passing of responsibility to local authorities and still maintaining the principle of equity in health care to public services is challenging for central government. However, it can be argued that despite the central government passes on tasks, it still controls the health care services through directives, instructions, supervision and auditing (Johnsen, 2006). For example, although the responsibility for primary care is delegated to the municipalities (this includes GP scheme), the central government is in control of setting all GP's source of incomes (Johnsen, 2006).

State ownership of the hospitals led to the establishments of four regional health authorities (RHAs); Northern, Central, Western and South-East Norwegian Regional Health Authority. RHAs' main task is to plan the development and organization of specialized health care according to needs of the regional population while the services are provided by the regional health authorities' health enterprises and agreement with private practices. The aim of the health enterprise is to provide high quality specialists health care on an equitable basis to patients in need, irrespective of age, sex, place of residence, financial circumstances and ethnic background (The Act on Health Enterprises). The enterprises (24 Health enterprises per January 2007) are responsible for one or several somatic hospitals each given a catchments area to provide high quality health care services according to the need of the population.

The organization of the specialist health care is often referred to as ‘the health enterprise model’ because it is based on a purchaser- provider division (Johnsen, 2006); RHA purchases health services while health enterprises along with contracted hospitals and private specialists provide specialists health care. About 1/3 of all somatic outpatient activity is provided by private specialists in 2008.

The Norwegian health care system is predominantly tax financed. Hospitals are financed by a mix of block grants and activity based financing. The financing of private specialists consists of a fee-for-service from the National Insurance Scheme, out-of-pocket payments and lump sum grants from the regional health authorities. The National Insurance Scheme covers all persons who either are residents, or working as employees in Norway.

2.1 Private health Care System

Although the Norwegian health care system is best described as public, regional health authorities are allowed to contract with private agencies whether it is hospitals, specialists or outpatient clinics making the private sector nearly fully embedded in the public system. Some not-for-profit private hospitals, such as the *diaconal hospitals*, owned by the Norwegian church are financed and fully embedded as a piece of the Norwegian health care

Contracted *for- profit- hospitals* are financed by the National Insurance Scheme through activity based financing based on the DRG system and patient fees. The part of activity in private hospital that is not contracted with the regional health authority (hence, without a referral from a GP) is mainly financed by a total fee paid out of-pocket by patients. In 1990 the number of profit hospitals was modest 2 and it significantly increased to 28 by 2004. This can be explained mainly by the attractiveness and changes of the private hospitals’ external environment. Firstly, the change in hospital reimbursement system; activity based financing is introduced in 1997 based on DRG points. Secondly, during period 1999-2004 the Ministry of

Health had a large increase in authorization of private specialists. Thirdly, the hospital reform 2002 meant a large scale contracting with private hospitals to reduce waiting times in public hospitals (Midtun, 2007). Finally, the introduction of free hospital choice reform in 2002 aimed to improve the patient's rights to choose in which hospital to receive elective treatment including contracted for- profit private hospitals and thereby granting the population equal access to high quality health care. Some of the major contracted hospitals are: Aleris hospital and medical center, Hjelp 24 NIMI AS and Volvat medical center.

Besides from private hospitals, *private contract specialists* make up the other part within the private specialized health care sector in Norway and provide different types of services. However, private specialists do not provide inpatient stay. Even though this type of outsourcing is quite small compared to the overall treatment (Askilden et al., 2007), the number of contracted private specialists accounted for 1,170 man-labor years in 2008. However, many patients make use of private specialists due to services not included in public services, shorter waiting time and no referrals are needed to enter for those patients willing to pay all the costs out of pocket.

The operating grant of contracted specialist health care is dependent upon varies factors: the need for expensive treatment and assistant personnel, cost of premises and the size of the contract measured in man-labor years (20-100% of an estimated man-labor year) (Midtun, 2007). In addition, contracted private specialists receive reimbursement from national insurance scheme and out of pocket patient payments.

It is common for private specialists to have a part time employment in the public hospitals, also referred to as moonlighting. According to Midtun (2007) a longstanding tradition exists regarding specialists combining positions in the private and public sector and is in accordance with employee regulations. The hospital and its employed physicians are allowed to plan for overtime work within the main hospital job since exemption is made regarding regulation of forbidding planned overtime. According to the Ministry of Health and care services (2003) 50% of the private specialists are estimated to have a part time employment at a public hospital.

2.2 Access to the specialists health care

At a general level, access to health care refers to the ability to secure a specified set of services, at a specified level of quality, subject to a specified maximum level of personal inconvenience and cost, whilst in possession of a specified level of information (Goddard and Smith, 2001). Several factors can have an impact on a patient's access to health care: availability, quality, financial costs, informing patients of the possibilities of treatment, time costs, capacity and travel distance. However, measuring access is complicated and can rarely be observed directly. In this study we measure access by incorporating two elements: the capacity of hospitals and the distance from a municipality to be supplied to the municipality offering specialist health care in terms of a discount factor that converts the distance to estimated access (Iversen and Kopperud, 2002). Since our focus is accessing specialist health care, figure 1 illustrates the different ways a patient can enter the specialized health care services.

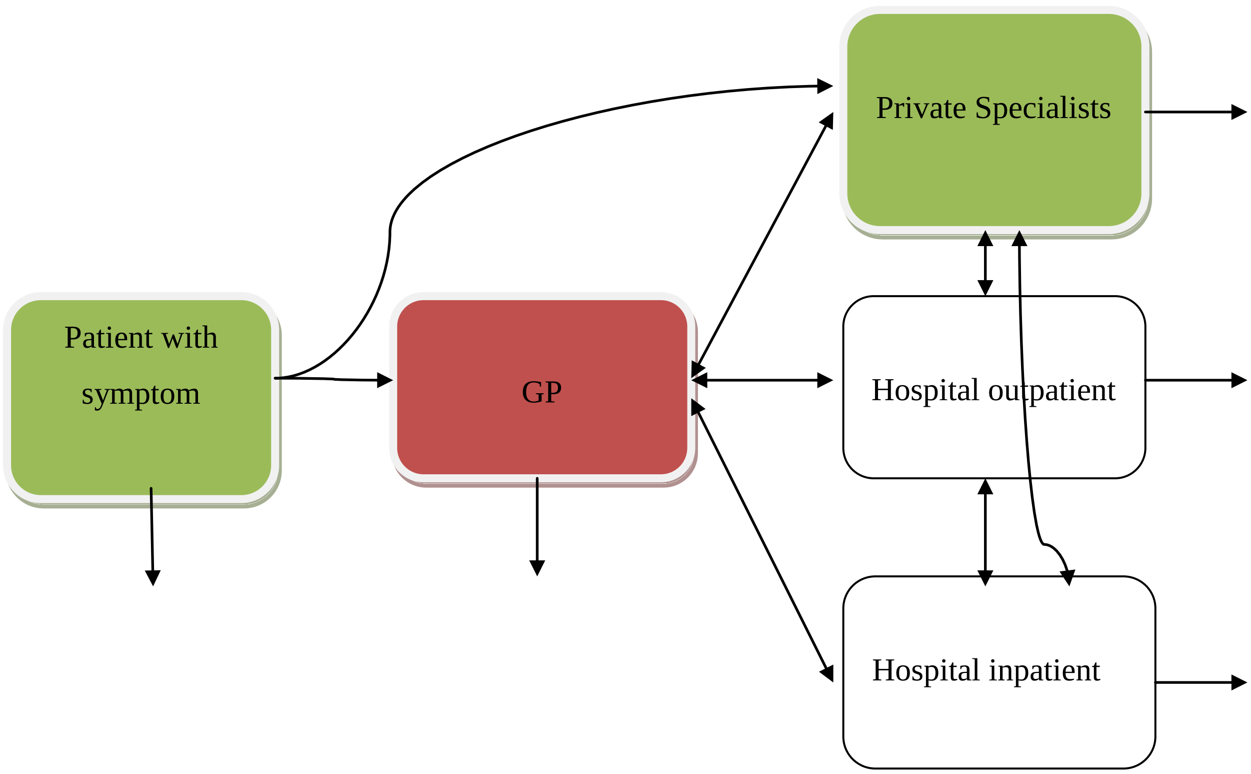

Figure 1. Non – emergency care patients flows, Iversen and Kopperud (2002) with modifications.

Figure 1 illustrates the different patient flows in a non- emergency setting. A patient with symptoms may choose not to make use of GP. This may be due to ethical consideration, preferences or religious beliefs. However, it is most likely that a patient with symptom in need for health care will visit a GP. The general practitioner may choose to treat the patients by himself or issue a referral to enter specialist health care: hospital inpatient stay, hospital outpatient visit or private specialist visit. The patients are then freely to choose where to receive treatment (The Directorate of Health, 2009), even though studies show that few patients do make use of this opportunity (Vrangbæk et al., 2007). A patient with symptoms may also contact a private specialist directly. Private specialists do not provide inpatient services.

Clearly, accessing the specialist health care is determined by the patient himself and the GP. In this relationship we assume that the patient have preferences for his own health, income and leisure (Iversen and Kopperud, 2002). GP, on the other hand, is assumed to have preferences for his patient’s health and his own income (Iversen and Kopperud, 2002). It is reasonable to assume that GPs’ working values and individual characteristics i.e. pushy patients, may determine the treatment or referral for the patient to receive specialized health care. Moreover, studies show that patients of higher socio economic level communicate more actively, show more affective expressiveness and is more involved in the treatment decision (Willems S. et al., 2005). This may induce to higher referral rates among patients with high socio economic position.

A visit to a GP requires very low out of pockets copayment (132 kroner from 2009-01-07). Assuming that the patient and the GP both agree for a referral, out-of pocket payment for outpatient hospital or private specialists is 295 kroner per 2009-07-01. There is no-out of pocket payments for inpatient hospital services. Patients choosing to enter the private specialists without a referral have to pay the total cost out-of pocket.

The GP is financed through grants from the municipality according to the number of patient on their list, activity based financing based on number of treatments and diagnostics and out-of-pocket payment by the patients (Brigham, 2009).

A general Norwegian health policy guideline is the LEON- principle (Lavest effektive omsorgsnivå); meaning that care should be provided at the Lowest Efficient level of care (Ministry of Health and Care Services, 2006). Thus, if justifiable, care should be provided at primary care. In this respect GPs play a meaningful role; not only do they provide primary care but they also issue referrals to elective patients before gaining access to specialist health care. Hence, they act as gatekeepers (Tjerbo, 2009). Tjerbo (2009) argues that fear of losing patients results in GP's acting more as 'advocates' rather than gatekeepers and an increase in 'unnecessary referrals'. In the next section we explore the laws and regulation that govern patient's rights to health care and access to services.

2.3 Equity and access regulation

Although several reforms have taken place in the recent decade in the Norwegian Health care system, solidarity and equal access to care regardless of socio - economic status, sex, age and area of living has been a central goal of Norwegian health policy (Heggestad, 2009). Some recent reforms i.e. the Norwegian Hospital Reform of 2002 also aimed at securing access to be distributed more equally (Nerland and Hagen, 2008).

There are several laws and regulations undertaken by the parliament to secure equitable access to health care. The Patients' Rights Act stipulates the rights to be a patient and its goal is '*to give population equal access to high quality health care by granting patients rights in their relations with the health service*'. The Patients Rights Act also gives the right for patient to choose where to receive treatment (The Directorate of Health; 2009) and is an option for patients with referral. The free choice of hospitals also includes private hospitals with an agreement with the regional health authorities. To help patients and health personnel to make sound decisions, an information internet site was launched, www.frittsykehusvalg.no, containing information about public and private hospitals, waiting times and quality indicators.

After the state took over ownership of the hospitals, the Act on Health Enterprises was launched and section 1-1 stipulates that the aim of the health enterprises is to provide high quality and equitable specialist health care to patients in need, independent of age, sex, living area, financial and ethnic background (The Act on Health Enterprises, 2002). A white-paper – 'National strategy to reduce social inequalities in health' states that health is not equally distributed between social groups and the marked health inequities is due to those who are most financially privileged (Ministry of Health and Care Services, 2006). It suggests four priority areas to cope with social inequities. Clearly, from the above legislations and white paper, one central objective of the Norwegian health care system is equity of access. But why is the objective of access and equity in health care so vital?

3. The importance of access and equity in health Care

World Health Organization states that universal coverage requires that everyone within a country can access good quality services irrespective of, age, sex, area, economy and ethnic background (WHO, 2008). The Norwegian Act on Health Enterprises was launched and section 1-1 stipulates that the aim of the health enterprises is to provide high quality and equitable specialist health care to patients in need, independent of age, sex, living area, financial and ethnic background (The Act on Health Enterprises, 2002). But why is equity in health care so important?

A common first response is that health care is of special importance because it is a necessary condition for happiness (Daniels and Sabin, 2002). According to Tobin (1970) health care services are regarded as fundamentally necessary for the good life. Moreover, Daniels and Sabin (2002) argue that the central moral importance of treating disease with effective health care services is to protect normal functioning because it contributes to protecting opportunities. Hence, health care increases our quality of life and enriches what life has to offer. Aristotle termed this concept "flourishing" (Culyer, 2001). A report on the ethical implications of differences in the availability of health services states that health care is of special importance, among other things, due to its role in relieving suffering, preventing premature death, restoring functioning, increasing opportunity and providing information (President's Commission for the study of ethical problems in medicine and biomedical and behavioral research, 1983).

Since, health is fundamentally necessary to the good life and resources are scarce, the planned use of health care is rationed in accordance with a country's stated equity principle. Several equity principles exist and in the next section we present the most widely used.

3.1 Principles of Equity

Before turning on to explore the principles of equity in health care services, let us first emphasize the unique meaning of *equity* and *equality*. Equity and equality in health care has a moral and ethical dimension. Equality is used to describe a distribution that is equal (Pereira, 1993) i.e. distributing health care services equally among the population. Equity, on the other hand, refers to a distribution that is in essence *fair* or *just* (Pereira, 1993) i.e. distributing the health care services according to need.

The concept of equity is considered to be elusive (Goddard and Smith, 2001) and difficult to interpret and operationalize (Birch and Abelson, 1993). One ideal definition is proposed by Powell and Exworthy (2003, p. 53):

> ’Full equality’ would presumably result if all with equal needs, endowed with equal propensities to consult and faced with equal access to health care, consulted with equal-quality GPs for equal lengths of time and equal contents of consultation. They would, if necessary, be referred, after equal waits, to consultants of equal quality who treated them equally and achieved equal outcomes’

Powell and Exworthy's definition of equity is an ambitious ideal and should be a goal worth pursuing. Several principles, definitions and policy statements of equity exist and the following distinguishes between three alternative principles: ‘equal access to health care, ‘equal utilization of health care for those in equal need of health care’ and ‘equal/equitable health outcomes’.

One of the most popular equity objectives is ‘Equal access to health care for those in equal need’ (Powell and Exworthy, 2003) and is considered as a central target of many health care systems (Goddard and Smith, 2001). The principle implies that those with equal needs have equal *opportunities* to access health care, and similarly those with unequal needs have appropriately unequal *opportunities* to access health care (Oliver and Mossialos, 2004). However, those in equal needs may choose to not make use of health care due to i.e. individual preferences or religious beliefs. These acceptable reasons for use of health care should not be interpreted as inequity in health.

Turning to the concept of ‘equal utilization for equal need’ implies that those for equal need for health care make equal use of health care (Oliver and Mossialos, 2004). This concept needs great care when interpreting, because differences in utilization do not necessarily mean that the distribution is inequitable. Let us assume two patients are in equal need for health care, for utilization to be equal requires that one of the following applies (Mooney et al., 1991 p. 478):

(a) That consumers all have the same preferences for health care
(b) That consumers’ preferences in consuming health care are totally irrelevant or are deemed to be so;
(c) That consumers’ who have a higher/lower than average preference for health care face negative/positive discrimination in access to health care.

According to Mooney et al. (1991) proposition (a) does not hold, and accepting this equity concept implies acceptance of proposition (b) or (c) thereby accepting that health care is a merit good; thus, a radical departure from traditional welfare economics. Moreover, this principle depends upon more proactive efforts by policy makers and would require individual’s choice to consume health care and preferences to be overridden.

Turning on to the last principle ‘equal/equitable health outcomes’, as implied in the terminology, emphasis equal health outcomes, for example as measured by mortality or morbidity, and focuses on health rather than health care. This concept is highly undesirably because it intervenes too much in how people choose to live their lives and is potentially very costly.

In the Norwegian health care system and in the Act on Health Enterprise specialist health care should be rationed according to ‘equal use for equal need’ (The Norwegian Act on Health

Enterprise). According to Johnsen (2006), the health policy regarding the provision of health care services is based on need. Iversen and Kopperud (2002) argue that securing ‘equal use for equal need’ is the best policy interpretation for Norway. The authors argue that Norway ranks high as one of the most sparsely populated countries in Europe (an average of 15 persons per km^2), and ‘equal access’ principle would require that all persons will have the same distance to specialized health care, which seems to be highly unrealistic. The Norwegian population density is very unevenly distributed among the 430 municipalities i.e. 2.1 persons per km^2in Loppa municipal to 1192.5 persons per km^2in Oslo.

Since Norwegian health care system is based on ‘equal use for equal need’, we use the concepts of *horizontal equity* to audit whether this objective is accomplished. Various studies use this concept to assess whether the equity objective in health care is fulfilled (Morris et al., 2005, van Doorslaer 2006). *Horizontal equity* refers to the equal use of health care services for those with equal need, while *vertical equity* refers to the unequal use of health care services for those with unequal need. Horizontal inequity will be defined here as individuals with the same levels of need utilizing different amount of specialist health care according to factors that ought not to affect use. That is, if use varies with non -need variables i.e. education, household income, ethnicity and access to health care.

4. Literature review

Nerland and Hagen (2008) conducted a study to find out whether the introduction of state ownership to hospitals in 2002 has lead to improved accessibility to somatic specialist health care. They find that the non-need indicators waiting time, travel distance and primary care supply has a significant effect on use of specialist’s health care. Thus, horizontal inequity exists. The analysis of panel data demonstrates that effect of distance between an inhabitant’s residence municipality and nearest hospital has increased and is negative; indicating that long traveling distance to hospitals has not resulted in the same increase in utilization as for those living close to a hospital. A patient living in a municipality fifty kilometers away from the nearest hospital was estimated in 2001 to have on average 3 percent lower use of specialist health care compared to a patient living in a municipality offering specialized health care. For patients living in a municipality hundred kilometers away from the nearest hospital the estimated number was 6 percent lower use compared to a municipality offering hospital care.

In 2005 these numbers have increased to 3.7 and 7.4 percent respectively. According to the authors, one explanation is that patients and their GP living within a municipality offering hospital services may be better informed and make more use of these services. Moreover, they also suggest that patients living far away from a hospital may choose to not make use of specialized health care due to marginal need for care.

Iversen and Kopperud (2002) study whether the Norwegian policy of distributing health care according to need is accomplished. Using data from the 1998 survey of Living Conditions by Statistics Norway and an index for accessibility of health care, they find that self-rated health varies significantly with use of public hospitals in the sense that poorer self-assessed health makes more use of public hospitals. However, the use of private specialists did not vary according to self-rated health. Accessibility indices had significant effects on the utilization of the private specialists. They find that access to hospital beds contributes negatively to a private specialist visit, while unexpectedly access to hospital physicians contributes positively to a private specialist visit. However, they find that the better the access to private specialists is, the higher is the probability of a visit to a private specialist when access to hospital physicians is disregarded.

Aakvik and Holmås (2006) investigate whether economic conditions and access to primary health care have a significant effect on total mortality rates. Access is measured as the number of general practitioners per 1000 inhabitants at the municipality level. Panel data are used on municipality data from 1986 to 2001 gathered from Statistics Norway and from the Norwegian Social Science Data Services (NSD). They conclude that there is no significant relationship between GPs per capita and mortality rates.

According to Goddard and Smith (2001) geographical access has a significant effect on use of health care. Rice and Smith (2001) argue that this may due to “supplier induced demand”; meaning that individuals might be ‘induced’ to use more health services in areas with significantly high provision of health care. Contrary, people living in areas with low provision of health care may experience “supplier suppressed demand”. Goodman et al. (1997) study whether distance from the residence to the nearest hospital has an impact on hospitalization and mortality. After controlling for age, sex, bed supply, median household income, rural residence, academic medical center and presence of nursing home patients , they find that distance to hospital is an important influence on hospitalization. Residents living more than 30 minutes away from the hospital make less use of hospitalization compared to residents living in a zip code with a hospital.

Finnvold (2009) in a working paper about equity in the Norwegian health care system makes a distinction between “micro studies” and “macro studies”. “Micro studies”are concerned about specific treatments or services directed towards a target group i.e. the influence of distance on uptake of plastic surgery. These studies are based upon patient’s journals or clinical evaluation by a health personal. One main conclusion from these studies is that a relationship between need for health care and use or access to health care does not exist and that people with low socio economic status make less use of health care services when adjusted for need. Turning on to the literature on “macro studies”, these studies are concerned about general population surveys; whether the use of health care is based on need (individuals self-assessed health). These studies find that effect of socio economic gradient on use of health care have changed over time. While previous studies show that patients in high socio-economic positions use more of health care, latter studies find that patients in low socio-economic position use more services also when adjusted for need indicators.

Two literature reviews Dixon et al. (2006) and Goddard et al. (1998) find that people in higher socio-economic groups are using more specialized health care compared with people in lower socio-economic groups when adjusted for need. In explaining the differences, Dixon et al. (2006) distinguish between demand and supply factors. Differences in health beliefs, communication skills, self-efficacy, knowledge and the cost of travelling to receive care are suggested by the authors to explain some of the different pattern of health care utilization.

Our data sets enable us to make a number of contributions to this literature. First, we are interested in whether equal access to specialized health care irrespective of place of residence is achieved in the Norwegian health policy. Access incorporates three elements: (i) the capacity of specialists health care (ii) the distance from residence to the nearest hospital (iii) a distance decay effect in that the likelihood of a patient making use of specialists health care decreases with increasing travel distance to the nearest hospital. Second, the data are more recent covering 2008 data. Finally, there have been a number of developments with possible implication on accessibility: the state ownership of hospitals in 2002 and the following establishments of regional health authorities and health enterprises, free hospital choice introduced in 2001 and the Act of Patient Rights, the regular GP scheme in 2001 and national plans to cope up with social inequalities in health (The White Paper Report no. 16 (2002-2003) *Prescription for a healthier Norway*, The White Paper Report (2006-2007) No. 20 N*ational strategy to reduce social inequalities in health*).

5. Aims of the Study

The present study falls into two parts. First, we construct accessibility indices as a proxy for access to specialized health care. The aim is to find out whether the principle of *equal access* to specialized health care is fulfilled and in accordance with the Norwegian health policy. Second, we use the constructed accessibility indices in order to study whether access has as impact on use of specialized health care. We include some demand side variables i.e. age, sex, socio-economic position, chronic illness and self-assessed health, due to their potential confounding effect and because they are strong indicators of need for care i.e. self assessed health and chronic illness (Jylha, 2009; Oliver & Mossialos, 2004).

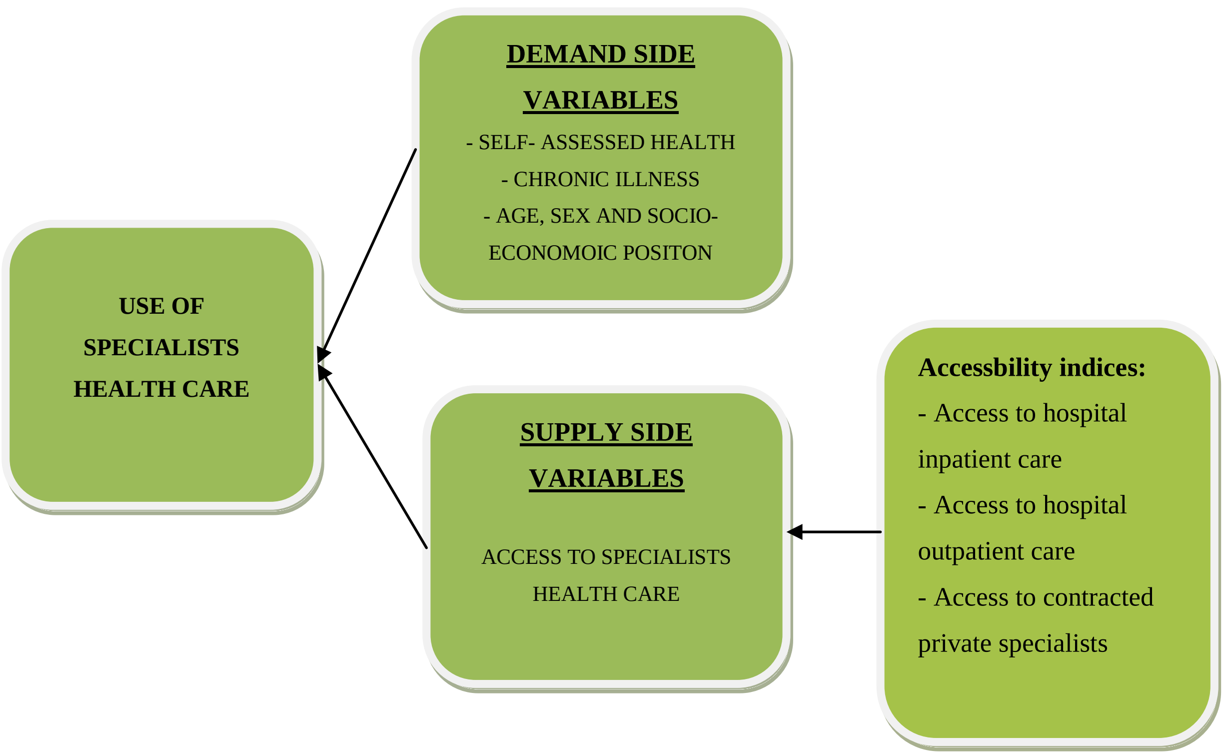

Figure 2. Research model.

The research question 1: **Is the principle of equal access to specialized health care in Norwegian health policy achieved**? The background for this question is to investigate whether the goal of the Norwegian health care system equal access to specialist health care services are fulfilled. There are several laws and regulation undertaken by the parliament to secure equitable access to health care i.e. the act on health enterprises and the Patients Rights Act. However, Kopperud (2002) found that access to specialized health care varies significantly between the municipalities, using the 1998 hospital capacity data.

The research question 2**: Does access have an impact on use of specialized health care?** This is a follow up question. Here we are interested in whether *access* influences the use of specialized health care. There is horizontal inequity in the Norwegian specialist's health care system if people in equal need for care are utilizing different amount of specialist health care according to factors that ought not to affect use i.e. geographical distance to specialized health care. The constructed accessibility indices in research question 1 are used as proxies for access. The specialist health care included is hospital inpatient, hospital outpatient and contracted private specialists. Previous studies have shown that geographical access has a significant effect on use of health care (Goddard and Smith, 2001; Nerland and Hagen, 2008; Goodmaen et al. 2007; Rice and Smith, 2001). Iversen and Kopperud (2002) study whether access has an impact on use of specialists health care. They find that access has significant effects on the utilization of contracted private specialists. Moreover, they find discrepancy between the patient's health status and the use of private specialists i.e. not rationed according to need and conclude that the use of private specialists seem to function as an alternative to general practitioner (Iversen and Kopperud, 2002).

Iversen & Kopperud (2002) used data from 1998; in our study we use the 2008 Survey of Living Conditions by Statistics Norway. Since then, two major reforms were implemented aimed to increase efficiency: a list system for GP's and the state taking over ownership of hospitals in 2002. Carlsen and Norheim (2005) in a study find that the list patient system leads to more competition for patients. Since GP financing is mainly based on the number of patients, there is an incentive for GPs to act less as gatekeepers for society and more as advocates for patients to avoid losing patients (Tjerbo, 2009). Hence, a different pattern on use of health care may be observed. Furthermore, preliminary results, following the state taking over ownership, point to some positive outcomes, such as decreased waiting list (Johnsen, 2006). This again may result in a different pattern on use of specialist health care.

6. Accessibility modeling

In this section we investigate whether the policy goal of equal access to health care is accomplished. We construct accessibility indices for the measurement of access to specialist health care. The index measures the perceived availability of specialized health care for each municipality within the four regional health authorities. The indices incorporate two elements: a measure of capacity of specialist health care and their proximity to the population of interest including a discount factor that converts the distance to estimated access. The final outcome is a number for each municipality reflecting access to specialist health care.

6.1 Capacity of Specialist Health Care

In our study the hospital capacity is measured along two- dimensions: *effective beds* and *physician man-labor years*. These data are provided by Statistics Norway. *Effective beds* are defined as the average available beds during the year. *Effective beds* are calculated by dividing the total amount of day-night beds with number of days a year. In addition to this we include the size of *the contract with private specialists health care*; 20-100% of an estimated man-labor year, which is estimated to 37.5 hours weekly work all along at least 44 weeks of the year.

Norway is very sparsely populated. The somatic hospitals differ a lot in terms of size and function. Each hospital is given a *catchment area*. The hospital is responsible for providing high quality specialist health care to the population within the catchment area. The number of patients included in each catchment area varies from 12,020 to about 401,335 inhabitants, with an average of 147,000 inhabitants per catchment area. Data on hospital catchment areas were collected through information available at their websites. An overview of all hospitals, public and non for profit hospitals with an agreement with RHA, is presented in appendix A, along with their catchment area.

The function of the 63 somatic hospitals, including specialists and non commercial hospitals, varies a lot according to its complexity. We can group the specialized health care supplied into three: supply at local level (*general-/local hospitals*), supply at regional level (*regional hospitals*) and supply at national (*tertiary care hospital*) level. A *tertiary care hospital* is defined as a university hospital with national responsibilities and treatment for patients referred from secondary care. These hospitals offer the most complex and technologically sophisticated services and because of its complexity i.e. teaching and research, specialty and expensive equipment are concentrated in few central facilities. *Regional hospitals* offer services that require more complex treatment and cannot be provided in a general- or local hospitals. A general- or a local hospital has the following minimum package of services: surgery division with acute medical treatment, internal medicine division with acute medical treatment, maternity ward and necessarily support functions within anesthesia, x-ray and laboratory services (Erikstein et al., 2006). Finally, some specialist hospitals exist. These hospitals concentrate on offering health care services of a few treatment types.

6.1.1 The Distribution of Hospital Capacity

The state ownership of hospitals from 2001 led to the establishments of five[1] health regional authorities, each responsible for the public hospitals in its region. Every region has its own regional hospital (table 1).

REGIONAL HEALTH AUTHORITY	COUNTIES INCLUDED	REGIONAL HOSPITAL
Southern and Eastern Norway	Østfold, Akershus, Oslo, Oppland og Hedmark, Vestfold, Buskerud, Telemark, Aust-Agder og Vest-Agder.	Ullevål University hospital.
Western Norway	Rogaland, Hordaland og Sogn og fjordane.	Haukeland University hospital.
Central Norway	Møre- og Romsdal, Sør-Trøndelag og Nord-Trøndelag	St. Olavs University hospital
Northern Norway	Nordland, Troms and Finnmark	North – Norway University hospital

Table 1. An overview of Regional Health Authorities, counties included and regional hospital.

The data of hospital *effective beds* and *physician man-labor years* are provided by Statistics Norway, 2007 data, and are divided by the number of population of interest to result in a ratio *per head effective beds* and *man labor years*. For most of the general- local hospitals, the number effective beds and man-labor years were captured directly from the available data and

[1] After the merge between Southern and Eastern health authority in 2007, today there are four health regional authorities.

divided by the catchment area of interest. For an overview over hospitals and their catchment area see Appendix A. However, the issue becomes more complicated for a national responsibility hospital (*Rikshospitalet University Hospital*) and regional hospitals due to its construction; providing both national- and regional level treatments to its patients, and at the same time providing general- and local hospital treatments. Consequently, we use a distribution formula to allocate the activity at national, regional and local level (table 2).

	Percentage rate; the proportion of beds that is assigned to the catchment area	Percentage rate; the proportion of beds that is assigned to region inhabitants	Percentage rate; the proportion of beds that is assigned the country
Haukland Uni. Hos.	35.00 %	65.00 %	0.00 %
St. Olavs Hospital	35.00 %	65.00 %	0.00 %
Nord- Norge Tromsø	35.00 %	65.00 %	0.00 %
Rikshospitalet Uni. Hos.	0.00 %	20.00 %	80.00 %
Ullevål Univ. Hospital	35.00 %	65.00 %	0.00 %

	Total effective beds available for the hospitals catchment area	Total effective beds available to the region	Total effective beds available for the country
Haukland Uni. Hos.	341.25	633.75	0
St. Olavs Hospital	307.3	570.7	0
Nord- Norge Tromsø	178.15	330.85	0
Rikshospitalet Uni. Hos	0	186.2	744.8
Ullevål Univ. Hospital	270.2	501.8	0

Table 2. Example: The distribution of effective beds according to catchment area, region and to all inhabitants in the country using percentage estimates.

Haukland University Hospital at Bergen had a total amount of effective beds equal to 975. We assign 35 percent of its beds to its local catchment area, while the rest, 65 percent of the beds, are allocated within the region. This indicate that approximately 35 percent of its capacity is allocated to provide general-/local hospitals high quality specialist health care treatments, while the rest is allocated to tertiary care and regional care. This capacity percentage estimates is in accordance with capacity distribution presented in NOU 1996:5 (Kopperud, 2002).

The following percentage estimates are used for distributing effective hospital beds and man-labor years in accordance with the hospital's catchment area and region inhabitants: the activity of Haukland University Hospital, St. Olavs hospital and University Hospital of

Northern Norway is distributed 65 percent to the number of inhabitants in the region. The Ullevål University Hospital is estimated to direct 65 percent of its capacity to providing specialist's health care to the number of inhabitants in the region and 35 percent to the number of inhabitants in the hospital's local catchment area. Since, Rikshospitalet is the only hospital with extensive national responsibilities, 20 percent of its activity are directed to the number inhabitants of the region while 80 percent to the number of inhabitants in the country.

There are some other difficulties when considering capacity distribution. Since we are interested in the capacity and the availability of specialist health care in each municipality, we also need to take account of the various locations of hospital divisions/premises. For example, Hospital Østfold is divided into five hospital divisions. In Halden municipality, we have *hospital Østfold division Halden*, in Sarpsborg municipality we find *hospital Østfold division Sarpsborg*, in Fredrikstad municipality we find *hospital Østfold division Fredrikstad*, in Moss municipality we have *hospital Østfold avdeling Moss* and finally hospital Østfold in Askim. Our data include higher level capacity data i.e. Hospital Østfold and not operationalized to the five hospital divisions. Therefore we have decided upon a distribution formula to allocate the capacity to each of the hospital divisions. We have decided to weight the number of beds and man-labor years in accordance with the municipality's population:

$$b_i = \frac{number\ effective\ beds}{\sum_{i=1}^{5} Pi} * p_i \qquad m_i = \frac{number\ of\ man\text{-}labour\ years}{\sum_{i=1}^{5} P_i} * p_i$$

Where $b_i$the number of effective beds for each municipality is, m_i is the number of man-labor years and P_i is the number of population in the municipality.

Municipal	Number of innhibitants	Percentage of the total number of inhabitants in the five municipalities	Number of beds
Askim	14740	7.48 %	37.16971942
Fredrikstad	72730	36.90 %	183.4025572
Halden	28400	14.41 %	71.61601299
Moss	29560	15.00 %	74.54117408
Sarpsborg	51660	26.21 %	130.2705363
Totalt	197090	100.00 %	

Table 3. **Hospital Østfold; distribution of the number of beds at municipal level**

As the table above indicates, Askim municipality will be allocated 7.48 percent of the total of beds or 37.16 beds. Fredrikstad, Halden, Moss, Sarpsborg municipalities will be distributed 183.40, 71.61, 74.54 and 130.27 number of beds respectively.

The same problem occurs with *Vestfold hospital. Vestfold hospital* has premises located in more than one municipality but available to us is the total number of beds and physician man-years at Vestfold hospital. Hence, we need a distribution formula to allocate a number of capacities to the municipalities with premises providing specialist health care. Vestfolds hospital has divisions in three municipalities in Vestfold; the hospital in Tønsberg located in Tønsberg municipal, the hospital in Larvik located in Larvik municipal and finally the hospital in Sandefjord located in Sandefjord municipal.

	Percentage ratio distribution of total beds	Total available beds for each division
Hospital Vestfold division Larvik	25.00 %	106.5
Hospital Vestfold division Sandefjord	15.00 %	63.9
Hospital Vestfold division Tønsberg	60.00 %	255.6

Table 4. Vestfold Hospital; distribution of the number beds to the hospital divisions.

Here we did not allocate the hospitals capacity in accordance with the municipalitites population since the hospitals located in Sandefjord and Larvik are small and has less activity compared to the hospital located in Tønsberg. Table 4 shows the assigned percentage estimates used and has been decided upon to reflect the activity level for the hospital divisions. The same percentage estimates are used when distributing the number of man-labor years to the hospital divisions. Hospital division Larvik, Sandefjord and Tønsberg is distributed (106.5), (63.9) and (255.6) beds respectively.

Hospital in Hedmark is made up of two hospitals located in two municipalities; Elverum and Hamar municipal. Our data provide us with the total number of beds and man-labor years at Hospital Hedmark, and not allocated to each of the two divisions. The two divisions are assumed to be equal in services offered, so we divide the capacity equally between the divisions.

	Percentage ratio distribution of total beds	Total available beds for each division
Hospital Hedmark division Elverum	50.00 %	166
Hospital Hedmark division Hamar	50.00 %	166

Table 5. The distribution of beds to Hospital Innlandet division Elverum and hamar.

In Appendix B the capacity measured by total number of *effective beds* and *man-labor years* for each hospital is displayed.

In this study we are interested in access to hospitals providing a minimum standard package of specialist health care. Therefore, hospitals that do not fulfill this requirement are excluded. We have excluded the following hospitals due to a high degree of specialization: Kysthospital in Hagevik, Haugesund rheumatism hospital, epilepsy center- SSE, Heart center in Oslo, Granheim Lung Hospital, Martina Hansen's hospital, Rheumatism hospital Lillehammer and Betanien hospital. Florø hospital is excluded because it does not offer the required minimum standard package of specialist health care.

Turning on to the capacity of contracted private specialists, these data were obtained by contacting the respective administration of regional health authorities. The information contains the size of the contract (20-100 % of an estimated man-labor years) and the municipality where the service is provided. The data at municipality level where then divided by the population at the respective region, resulting in a simple ratio "man-labor years per head". Appendix C shows the contracted man-labor years at municipality level by municipality.

6.2 Geographical distance to specialists health care

A measurement of accessibility should not only incorporate the capacity of the hospitals but also its *attractiveness* as measured by the physical distance to specialist health care. It is reasonable to suggest that individuals with low travel distance to specialist health care are more opt to use specialist health care compared to individual living in rural areas. In this section we introduce a deterrence function incorporating high attractiveness to specialist health care when the distance is low. Conversely, high distance to specialist health care should result in low attractiveness.

A municipality *j* providing specialist health care at local hospital level is responsible for serving all the municipalities *i* of its catchment area, while the capacity at a regional- or national level hospital is directed to all the municipalities *i* in a region or a country, respectively. To take into account that distance reduces the perceived accessibility, we include in our model a factor$f(d_{ij})$. This factor is a distance weight from a municipality to be served *i* to the municipality where the service is provided *j* and is simply expressing the effect of distance on access. Our first assumption is that the first order derivative to be negative $f'(d_{ij}) < 0$, and the second order derivate to be positive $f''(d_{ij}) > 0$ (Iversen and Kopperud, 2002). The logic of the latter assumption is that an individual is opting to faster modes of transportation the longer distance to the 'target'. Haggett et al. (1977) suggests the following deterrence function:

$$f(c) = e^{-\beta c^{\alpha}}$$

where c is distance and β and α are parameters to be estimated.

The parameters β and α are chosen to maximize a suitable likelihood function. The chosen values are β = 0.2 and α = 0. This is in accordance with the assumptions in Carr-Hill et al. 1994. Giving higher values to β will exhibit high absolute value of the elasticity with respect to distance, contrary low values will place higher weights on long distances. The chosen decay function is then:

$$f\left(d_{ij}\right) = e^{-0.2 d_{ij}},$$

The first order derivate is the negative:

$$\frac{\partial f(d_{ij})}{\partial d_{ij}} = -0.2 e^{-0.2 d_{ij}} < 0 ,$$

The second order with respect to distance is then positive:

$$\frac{\partial^2 f(d_{ij})}{\partial d_{ij}} = 0.04e^{-0.2d_{ij}} > 0 .$$

From the expressions above, the decay function is expected to decline with distance at an increasing rate. Hence, using the distance in *time* (ranging from 0- 48 hours), higher weights is placed on distance compared to distance in *km* (ranging from 0 – 2800 km). The example below, illustrates the effect of the decay function on measures of distance.

Municipality: Ullensvang. Located in western region.

Local hospital: Odda Hospital.

Regional hospital: Haukeland University hospital

National hospital: Rikshospitalet University hospital.

	Distance from Ullensvang to local, regional and national hospital respectively in ***time***, d_{ij}	$f(d_{ij}) = e^{-0.2d_{ij}}$	Distance from Ullensvang to local, regional and national hospital respectively in **km**, d_{ij}	$f(d_{ij}) = e^{-0.2d_{ij}}$
Odda hospital	0.8	0.852144	39.7	0.000356
Haukleland unviersity Hospital	3.1	0.537944	131.5	3.78E-12
Rikshospitalet university hospital	6.61	0.266246	357.6	8.69E-32

Table 6. The effect of distance measure on the decay function.

As indicated by the table 6 above, the distance from a municipality to be served, Ullensvang, to the municipality where the service is provided, Odda, Bergen and Oslo, is 0.8 , 3.1 and 6.61 hours respectively. Or, when calculated in distance 39.7, 131.5 and 357.6 kilometer, respectively. When calculating the perceived access using *time*, the local capacity level (Odda hospital) is weighted 0.852, while using *km* the same capacity is weighted 0.000356. Thus, the distance measure in *time*, places high weights on capacity compared to distance in *km*.

The distance (d_{ij}) between the municipalities *i* and *j* is the perceived distance in *km* and journey *time* by car. InfoMap Norge AS calculated the travel distances between the 430 municipalities in Norway. To allow accurate drive-time calculation, the calculation was based on existing speed limits and possibly boat connections.

6.3 Accessibility modeling

In this section we consider the construction of a model for the measurement of the perceived accessibility to specialist health care service locations. We assume that the perceived accessibility to specialized health care is a function incorporating (i) the capacity of specialized health care in each municipality as measured by the number of effective beds, physician man-labor years and contracted private specialist man-labor years (ii) the distance from a municipality demanding specialist health care to the municipality where the services is provided (iii) a distance decay function placing lower weights to long distanced specialized health care. The final result is three *distance weighted* ratios for each municipality "*beds per head*", "*physician man-labor years per head*" and "*private specialists man-labor years per head*".

The perceived accessibility indices A_{ikr} for the residents in municipality *i* in catchment area *k* in region *r* can be described as follows (inspired by Carr-Hill et al. 1994):

$$A_{ikr} = c\left[\frac{1}{P_k}\sum_{j=1}^{n_k} S_j^{(1)}\, f(d_{ij}) + \frac{1}{P_r}\sum_{j=1}^{n_r} S_j^{(2)}\ f(d_{ij}) + \frac{1}{P}\sum_{j=1}^{430} S_j^{(3)}\, f(d_{ij})\right]$$

As mentioned earlier, the somatic hospital health services in Norway can be divided into three: supply at local level, supply at regional level and supply at national level. A local hospital in the catchment area *k* is providing its capacity $S_j^{(1)}$ to all the municipalities included in the catchment area. This capacity is then divided by the population of the catchment area P_k because we are interested in the relative size of the estimated supply. A regional hospital in the region *r* (r = 1,2,3,4), is serving its capacity to all municipalities included in the region (*j*=1,2,…,n_r), divided by the population of the region (P_r). Finaly, a national hospital is directing its services $S_j^{(3)}$ to the 430 exicting municipalities in Norway, divided by the Norwegian population P. The distance d_{ij} is calculated for each municipality serving specialist health care to the municipalities to be served. The decay function $f(\blacksquare)$ is included so that access is assumed to decline with distance and thereby making long distanced specialist health care less attractiveness. c is a constant.

The following example illustrates the use of the accessibility model (table 7) . The municipality chosen is Ullensvang and is located in the western region in Norway.

Municipality: Ullensvang. Located in western region.

Local hospital: Odda Hospital.
Regional hospital: Haukeland University hospital
National hospital: Rikshospitalet University hospital.

Capacity of specialists health care measured: Effective beds.
The number of beds local hospital: 46
The number of beds regional hospital: 975
The number of beds national hospital: 931

Distance to local hospital in km: 39.7 km.
Distance to regional hospital: 131.5 km.
Distance to national hospital: 357.6 km.

Local hospital catchment area population: 12 410
Regional population western Norway: 996 870
Population of Norway: 4 801 055

Table 7. Fact data: Ullensvang Municipality.

Before calculating the perceived accessibility for residents in Ullensvang municipality, let us first calculate the decay function $f(\blacksquare)$. In our study we assume that access declines with distance. The dictanse from Ullensvang municipality to the local, regional and national hospital is 39.7 km, 131.5 km and 357.6 km respectively. The effective beds available at the local hospital Odda are given high weights while lower weights are placed in the capacity of the national hospital. Using the decay function $f(d_{ij}) = e^{-0.2d_{ij}}$ we find:

Municipality	Distance to local hospital in *km* , d_{ij}	$f(d_{ij})$	Distance to regional hospital in *km*, d_{ij}	$f(d_{ij})$	Distance to national hospital in *km*, d_{ij}	$f(d_{ij})$
Ullensvang	39.7	3.56E-04	131.5	3.78E-12	357.6	8.69E-32

Table 8. Calculation of weight distances for Ullensvang municipality.

From table 8, the estimated *weight* on the available beds on the local hospital is 3.56E-04, for regional hospital 3.78E-12 and for national hospital 8.69E-32. Thus, the longer distance the lower weights on the capacity.

Using the fact table above, we can now calculate the perceived accessibility for the residents in Ullensvang municipality, included in Odda hospital's catchment area in, western Norway region as follows:

$$A_{ikr} = c\left[\frac{1}{P_k}\sum_{j=1}^{n_k} S_j^{(1)}\, f(d_{ij}) + \frac{1}{P_r}\sum_{j=1}^{n_r} S_j^{(2)}\ f(d_{ij}) + \frac{1}{P}\sum_{j=1}^{430} S_j^{(3)}\, f(d_{ij})\right]$$

$$= \left[\frac{1}{12\,410}46 * 3.56E-04 + \frac{1}{996870}975 * 3.78E-12 + \frac{1}{4801055}931 * 8.69E-32\right]$$

= 1,32E-06

The perceived accessibility for the residents in Ullensvang municipality is 1,32E-06. Or, 1.32E-06 beds for head in Ullensvang municipality *weighted* for distance.

The perceived accessibility number calculated above for municipality Ullensvang does not tell us much. In order to make sense of the indices, the calculated accessibility is standardized.

The standardized variable is normally distributed with a mean equal to 0, and standard deviation equal to 1. The following formula is used to standardize the variables:

$$X = \frac{K - \bar{k}}{\sigma_k}$$

Where X is the standardized variabel

K is calculated accessbility

$\bar{k}$ is the mean value of K

σ_k is standard deviation K

Hence, if a municipalities standardized variable exceeds 0 (X > 0), this implies that its perceived accessibility is higher than the average municipality. Contrary, if municipalities calculated standard variable is less than 0 (X < 0) its perceived accessibility to specialized health care is less than the average municipality. The interpretation of X is how many standard deviation units an observation is above or below the mean and makes it possible to *compare* and *rank* the perceived accessibility between the municipalities. We are especially interested in the municipalities with best and worst perceived accessibility. As the figure 3 shows, about 95 % of the municipalities accessibility are expected within +/- 1.98 σ_k, and about 68% of the values are within 1 standard deviation of the mean. The standardization was made in SPSS 16.

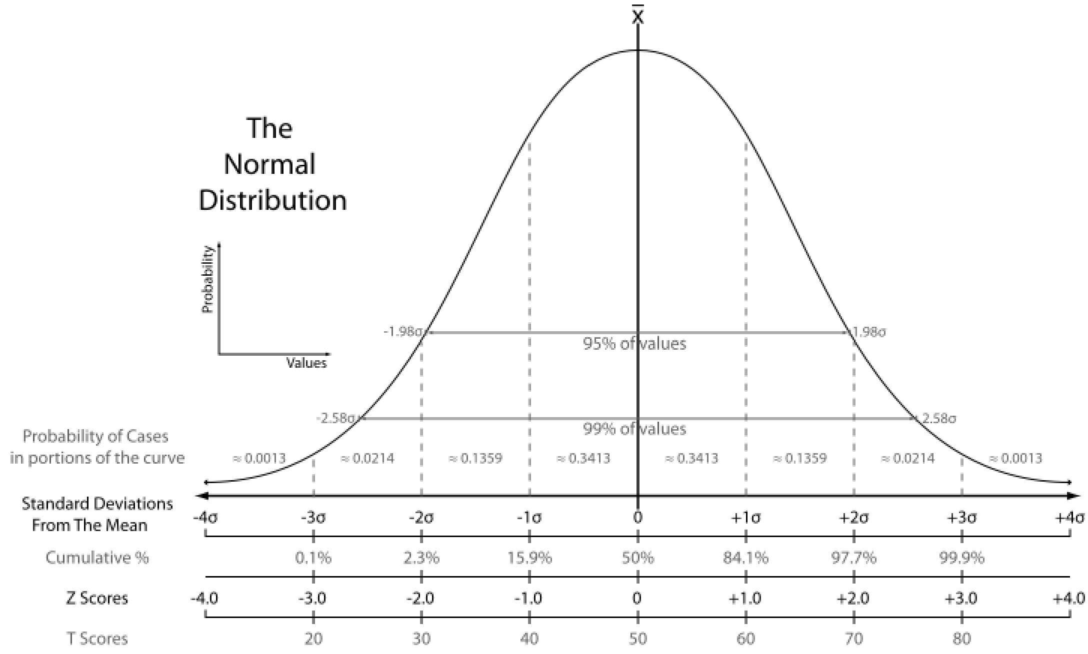

Figure 3. The Normal distribution.

6.4 Results

In this section we view the results of the municipalities' perceived accessibility as measured by *effective beds*, *physician man-labor years* and *private specialist man-labor years* weighted both in *time* and *km*. It is important to note that the distance measured in *time* and *km* differs significantly. The distance from *southernmost* city to the *northernmost* city in Norway is approximately 49 hours using the fastest mode of transportation and in kilometers approximately 2 800. This has some implications when calculating accessibility using the decay function $f(d_{ij}) = e^{-0.2d_{ij}}$, and the following parameters β = 0.2 and α = 0. When compared to distance measured on *time*, distance in *km* places lower weights on capacity at an increasing rate, making travel distances in km a cruder measure of accessibility.

6.4.1 Hospital Effective Beds

Table 9 below shows the top 10 municipalities with best perceived accessibility in both *time* and *km*. We start by looking at the distance in time. Compared with average municipality, Oslo has the best perceived accessibility and has 9.674 standard deviation better access to specialized health care. The reason for the good accessibility in Oslo is the short distance to hospitals. Oslo provides its residents' specialist health care at local, regional and national level and with a high per head capacity. The second best perceived accessibility is Odda, located in western Norway region. The estimated accessibility in Odda is 3.2 standard deviation better access to specialized health care when compared with average municipality. Odda hospital is located in the municipality Odda and provides specialists health care to a relatively small catchment area, resulting in high number of beds per head. This is also the explanation of the high accessibility in the municipality Ullensvang.

Distance in time		Distance in km	
Municipality	**Standardized Index**	**Municipality**	**Standardized Index**
Oslo	9.67415	Oslo	9.762199
Odda	3.202775	Odda	5.062402
Skien	3.077522	Lillehammer	4.860516
Porsgrunn	2.899862	Skien	4.582924
Siljan	2.84827	Tinn	4.148446
Lillehammer	2.810098	Drammen	4.04216
Øyer	2.487704	Bergen	3.895528
Bamble	2.476048	Tynset	3.822325
Ullensvang	2.411492	Lærdal	3.755674
Gausdal	2.282842	Voss	3.57091

Table 9. Top 10 municipalities with best perceived accessibility as measured by hospital effective beds.

On the top three, four and five best perceived accessibility, we find Skien, Porsgrunn and Siljan municipality respectively, located in eastern Norway, all included in Telemark county. The high accessibility at these municipalities is due to the small catchment area for the Hospital Telemark division Skien and Hospital Telemark division Kragerø. Thus, resulting in high ratio "beds per head". The municipalities Lillehammer and Øyer score high on accessibility because they are included in a catchment area served by Hospital Hedmark Lillehammer which provides a high number of available beds.

Turning on to distance measured by *km* in table 9, comparing the tables reveals some differences. Now, included in top ten best perceived accessibilities are the municipalities Tinn, Drammen, Bergen, Tynset, Lærdal and Voss. This because distance in *km* places low weight on even small distances and as a result the top ten municipalities with best accessibility are municipalities with a hospital facility. The municipality Oslo has 9.762 standard deviations better access to specialists health care compared to the average municipality, followed by the municipalities Odda and Lillehammer.

Distance in time	
Municipality	**Standardized Index**
Berlevåg	-2.04357
Vardø	-2.02037
Hasvik	-1.97211
Lebesby	-1.96978
Båtsfjord	-1.9494
Gamvik	-1.94126
Guovdageaidnu Kautokeino	-1.76995
Vadsø	-1.76191
Loppa	-1.73824
Kvænangen	-1.69495

Table 10. The bottom 10 municipalities with worst perceived accessibility as measured by hospital effective beds.

The municipalities with the worst access to specialized health care as measured by effective beds in our model are (distance in *time*): Berlevåg (-2.04) , Vardø (-2.02), Hasvik (-1.97) and Lebesby (-1.969). One characteristic of these municipalities are their location in Northern Norway, and in Finnmark county. Berlevåg has an access to specialized care that is -2.04 standard deviations lower than the average accessibility in Norway. The reason for this is the long travel distance and “beds per head” provided.

6.4.2 Physician man-labor years

The municipality with best perceived accessibility as measured by physician man-labor and distance in time, is Oslo followed by Lillehammer, Øyer and Gausdal all these located in eastern Norway region (table 11) . Oslo has a perceived accessibility that is 11.77 standard deviation units higher than the average accessibility in Norway. Again, this is due to hospital capacity in the capital Oslo, providing high capacity services at local, regional and national level. Hospital Innlandet division Lillehammer provides specialists health care at local level to the municipalities Lillehammer, Øyer and Gausdal. The reason for the high accessibility in these municipalities are (1) the high capacity of physician man-labor years and (2) the short distance between Øyer and Lillehammer (*0.3 hours*) and Gausdal to Lillehammer (*0.5 hours*). Compared to the municipality with average accessibility, Drammen (located just outside Oslo) has 2.13 standard deviations higher accessibility.

Distance in *time*	
Municipality	**Standardized Index**
Oslo	11.775561
Lillehammer	2.877092
Øyer	2.551674
Gausdal	2.344695
Drammen	2.139415
Lier	2.012067
Ringebu	1.904666
Nedre Eiker	1.881502
Røyken	1.832279
Hamar	1.806286

Distance in *KM*	
Municipality	**Standardized Index**
Oslo	11.871946
Lillehammer	5.084567
Drammen	4.035801
Bergen	3.984476
Skien	3.607238
Haugesund	3.465427
Tromsø	3.456263
Bodø	3.291367
Ålesund	3.282304
Lørenskog	3.166904

Table 11. The top 10 municipalities with best perceived accessibility as measured by physician man-labor years.

Turning on to the results weighted in distance *km*, we still have Oslo as the municipality with the best accessibility to specialist health care, followed by Lillehammer, Drammen, Bergen and Skien. Oslo has 11.87 standard deviations higher accessibility hospital physician man-labor years when compared to the average municipality. Furthermore, using the distance *km*, has as indicated, resulted in low weights being placed on capacity on even the smaller distances. Thus, municipality where the service is provided experiences the best perceived accessibility. In Drammen, Bergen, Skien, Haugesund and Tromsø we find Buskerud

Hospital, Haukeland University Hospital, Telemark Hospital division Skien, Haugesund Hospital respectively.

Distance in time	
Municipality	**Standardized Index**
Berlevåg	-2.09173
Vardø	-2.07065
Lebesby	-2.01937
Båtsfjord	-2.00342
Gamvik	-1.99267
Hasvik	-1.9651
Vadsø	-1.82862
Guovdageaidnu Kautokeino	-1.79077
Røst	-1.75977
Loppa	-1.68944

Table 12. The bottom 10 municipalities with worst perceived accessibility as measured by physician man-labor years.

Municipalities Berlevåg, Vardø, Lebesby and Båtsfjord are with the lowest perceived accessibility. The index is respectively -2.09, -2.07, -2.02, -2. Again, these municipalities are located in the Northern part of Norway, in Finnmark county. Båtsfjord has a perceived accessibility to health care that is 2.07 standard deviation lower than the average accessibility. The reason for the low accessibility for the residents in Northern Norway is due to the long distance to hospital care. Hospital care in Finnmark county is provided by Kirkenes Hospital and Hammerfest Hospital. The distances from municipalities Berlevåg, Vardø and Lebesby to Kirkenes Hospital are 5.43, 4.98 and 6.85 *hours* respectively, and to *Hammerfest Hospital* 10.02, 10.26 and 7.71 *hours* respectively.

6.4.3 Private Specialist Health Care

Turning on to the last accessibility index, capacity of contracted private specialists, the raw data where obtained by contacting the administration of the respective regional health authorities. The information contains the size of the contract (20-100 % of an estimated man-labor years) and the municipality where the service is provided (see appendix c). The data at municipality level were then divided by the population at the respective region, indicating that the contracted private specialists are available for the whole region. Finally, we adjust for distance, resulting in a distance weighted form of the simple ratio “man-labor years per head". In total there are 774 man-labor years contracted private specialists. As much as 26 percent of them are located in Oslo.

The municipality with the best perceived accessibility to contracted private health care is Oslo as measured by distance both in *time* and *km* (Table 13). This is because South-Eastern Regional Health Authority has approx. 200 man-labor years contracts with private specialists located in Oslo. Interestingly, when distance is measured in *time*, the remaining of the ten best perceived accessibility municipalities are located in eastern of Norway and neighbor/bordering municipalities and with very short distance to make use of the capacity in Oslo. Again, however, when using the distance in *km*, the results become unreasonable because now the capacity in Oslo is weighted low even for small distance neighbor municipalities.

Distance in *time*		Distance in *KM*	
Municipality	**Standardized Index**	**Municipality**	**Standardized Index**
Oslo	2.210394	Oslo	13.168939
Bærum	2.122598	Bergen	8.107699
Asker	2.108632	Trondheim	8.10536
Oppegård	2.062795	Tromsø	5.208638
Lørenskog	2.048875	Bodø	4.920448
Skedsmo	2.006078	Stavanger	3.324142
Nittedal	1.984661	Bærum	3.096208
Lier	1.984128	Os	2.362468
Rælingen	1.977956	Haugesund	2.020955
Drammen	1.968217	Levanger	1.756921

Table 13. Top 10 municipalities with best perceived accessibility as measured by contracted specialists health care.

High population density areas such as Bergen, Trondheim and Tromsø rank high on accessibility indices. The index is respectively 8.11, 8.10 and 5.2 standard deviations better access to private specialists than the average municipality. The municipalities with the worst perceived access are Vardø, Sør-Varanger, Berlevåg, Båtsfjord and Vadsø. The accessibility index is respectively -1.53, -1.53, -1.53, -1.52, -1.51. The calculated accessibility in Vardø is 1.53 standard deviations lower than the average municipality.

Distance in time	
Municipality	**Standardized Index**
Vardø	-1.53817
Sør-Varanger	-1.53491
Berlevåg	-1.53443
Båtsfjord	-1.52499
Vadsø	-1.51431
Lebesby	-1.50265
Gamvik	-1.49975
Unjárga Nesseby	-1.49604
Deatnu Tana	-1.48336
Bindal	-1.45596

Table 14. The bottom 10 municipalities with worse perceived accessibility as measured by contracted specialists health care.

Table 14, shows that municipalities Vardø, Sør-Varanger and Berlevåg has the lowest perceived accessibility. Furthermore, all the ten municipalities listed above are located in Northern Norway. This is not just due to the long distance to contracted private specialists but also due to the low capacity provided. The residence of South- Eastern part of Norway, the region with the highest number of contracted private specialist care, has a capacity *2.55 E-04* per head, while the residence of Northern Norway has *9.43 E-05* per head.

6.5 Conclusion

The aim of this section is to find out whether the residents living in different municipalities in Norway have equal access to specialized health care irrespective of whether they live very close to a hospital/private specialists or whether they live in a remote area. We construct accessibility indices to be used as a proxy for *access* to specialists health care. The accessibility indices incorporate three elements: (i) the capacity of specialists health care as measured by effective hospital beds, physician man-labor years and contracted private specialists, (ii) the distance from the municipality to be served to the municipality providing specialists health care, (iii) a discount function is introduced to place higher weights on capacity offered nearby and contrary low weights to long distanced capacity. The final result is three distance weighted ratios for each of the 430 municipalities: "*effective hospital beds per head*" , "*physician man-labor years per head*" and "*private specialists man-labor years per head*".

Distance from the municipality to be supplied to the municipality providing specialist health care is measured both in *time* and *km*. The discount function $f(d_{ij}) = e^{-0.2d_{ij}}$, and the parameters used in this study, β = 0.2 and α = 0 are equal to the assumption made by Carr-Hill et al. (1994). This implies that when compared to distance measured on *time*, distance in *km* places lower weights on capacity at an increasing rate. Hence, this disparity is presumably because travel distance in km, is a cruder measure of accessibility as compared to travel time (Nair S et al. 2009). However, independent of distance measure used, the results indicate that the capital *Oslo* has the best perceived accessibility to specialist health care and the most municipalities located in Northern Norway, more specifically Finnmark county has the worst perceived accessibility.

Iversen and Kopperud (2002) argues that because Norway is one of the most sparsely populated countries in Europe (15 persons per km^2) 'equal access' is hardly attainable since it implies that all inhabitants should have the same traveling distance to specialist health care. This study supports this conclusion.

It should now be clear that access to specialized health care depends on where you live. Our results revealed important variations in access to specialists health care which gives rise to ethical concerns. The residence in Oslo has the best perceived accessibility while the lowest perceived accessibility is estimated in municipalities in Northern Norway: Berlevåg, Vardø and Lebesby. In the next section we take the study a step further and ask whether these inequalities in access might have an impact on the use of specialists health care services (horizontal inequity).

7. Material and Methods

In this section, adapting an explorative approach, we investigate whether the policy statement on equity in the form of *equal use for equal need* (horizontal equity) is achieved in the Norwegian specialized health care system. We include three types of specialized health care: hospital inpatient stay, hospital outpatient visit and private specialist visit. In this study horizontal equity exists if use varies according to need as proxied by morbidity variables (*self* *assessed health* and the suffering of a *chronic illness*). Contrary, there is horizontal inequity if individuals with the same levels of need utilize different amount of specialized health care due to factors that ought not to affect use i.e. access to specialized health care. The analyses are organized as follows: we use the constructed accessibility indices in part 1 as a proxy for access to specialized health care for each municipality. We then merge these indices with data from 2008 Survey of Living Conditions by Statistics Norway, thereby combining individual data with a measurement of access to specialized health care, providing individual data about use, need, and access to specialized care. Identifying the determinants of horizontal inequity is analyzed using logistic regression. In case we find that non need variables (education, ethnicity, household income and access to specialist health care) vary with use, there is horizontal inequity and a discrepancy between public goals and surveyed practice.

7.1 Survey of Living Conditions

Statistics Norway investigates the living conditions of the Norwegian population including health conditions. The 2008 survey of living conditions is a representative data source for the population living in private households concerning population's health. The data are collected every three years and is a cross sectional study providing a description of the population's health at a single point of time.

Survey of Living Conditions 2008	**Number**	**Percentage**
Selected for the interview	10 000	
Not included (dead or residence abroad)	316	
Gross selection	9 684	100
Drop-out	3 219	33.2
Net sample (persons obtained interview with)	6 465	66.8
Collection method: Telephone- and face- to-face interview		
Average interview time: 36.2 minutes		
Collection period: 22.September 2008 – 30. Mars 2009		

Table 15. Key figures, the 2008 survey of living conditions. (Wilhelmsen; 2009)

The respondents were selected by stratified multistage sampling and include 10 000 respondents aged 16 or older. The sample is representative for the Norwegian population in private households. A telephone- or a face-to-face interview was obtained from 6 465 persons and performed by trained persons from Statistics Norway. The sample consists of 50.9 %

women and the average age is 49.8 years. Finally, the drop-out rate was 33.2%. A more extensive description of the methods of the survey, including the design and data collection can be found elsewhere (Wilhelmsen, 2009).

Data covering self-assessed health, chronic illness, age, gender, ethnicity, education, household income, private health insurance and use of specialized health care were all taken from 2008 survey of living conditions.

7.2 Measures

7.2.1 Dependent variables

The outcome variable was use of specialized health care (yes vs. no) and the type of specialized health care services is used: "*hospital inpatients stay*", "*hospital outpatient visit*" and "*private specialist visit*". The data are based on the following self-reported questions:

- *Hospital outpatient visit*: "Have you during the last 12 months visited a doctor in the hospital? It can be outpatient treatment, day surgery or/and day treatment. We think of all kinds of contacts. Do not include admission overnight and cases where you took a child, spouse or others."
- *Hospital inpatient stay*: "Have you during the last 12 months been a patient overnight in a hospital?"
- *Private specialists visit*: "Have you during the last 12 months, visited a medical specialists outside the hospital? We think of all kinds of contacts. Do not include cases where you took a child, spouse or others".

The response categories for all these questions were "yes" versus "no" use of health care services.

7.2.2 Independent variables

Individual-level variables

Adapting an explorative approach, we include data on *self-assessed health*, *chronic illness, age*, *gender*, *ethnicity*, *education*, information about *private health insurance* and *household income*. Information about *self-assessed health* is based on asking individuals to evaluate their overall self-perceived health on a five-point likert scale: *very good*, *good*, *fair*, *bad* and *very bad*. Since only *60* out of *6452* respondents chose the "*very bad health*" category, we collapsed the variable into 4 categories for a meaningful interpretation: *very good*, *good, fair* and *very bad/bad health* with *very bad/bad health* as reference. The second health related question was about whether the respondents have a chronic illness. The answer was classified in *yes* versus *no*, with *no* as reference.

As predisposing variables, we include sex (men versus women) with *women* as reference. Age was divided into four groups due to distribution of data; (i) 16-24, (ii) 25-44, (iii) 45-66 and (iv) 67 +, with *67* + age group as reference. Ethnicity was dichotomized as Norwegian versus non Norwegian, with *non- Norwegian* as reference. Household income was dichotomized as "Household Income High" (i.e. higher than the mean household income of 639,386 NOK) versus "Household Income Low" (≤ 639,386 NOK). "Household Income Low" was used as a reference in the analysis. Education was dichotomized as "Education High" (i.e. University/college- level education) versus "Education Low" (i.e. high school, middle school or no education) with "Education Low" as reference. Finally, there is a dummy variable for individuals who have "private treatment insurance", an insurance that gives the individual a right to examination, hospitalization and other medical treatment within short time.

Area-level variables

Several studies show that geographical access has a significant effect on use of health care (Goddard and Smith; 2001, Nerland and Hagen; 2008). As a proxy for access to specialized health care we use the constructed accessibility indices for "*per head hospital beds*", "*per head physician man-labor years*" and "*per head private specialists*". We use the distance measures in *time* because they place more realistic weights on capacity (see chapter 4). All these three variables are continuous. In addition, we included a dummy variable equal to one for individuals living within a municipality offering hospital care and zero otherwise and a dummy variable equal to one for individuals living within a municipality offering private specialist care and zero otherwise . These access variables were merged with individual-level variables by Statistics Norway (SSB). Table 16 shows the variables used in the study.

Variable	Source	Measure	Coding
Dependent variables			
Hospital inpatient last 12 months	SSB	Dichotomous	0= No, 1= Yes
Hospital outpatient last 12 months	SSB	Dichotomous	0= No, 1= Yes
Private specialists last 12 months	SSB	Dichotomous	0= No, 1= Yes
Independent variables			
Self-assessed health	SSB	Categorical	1=very good, good, fair 0= very bad/bad (REF).
Chronic Illness	SSB	Dichotomous	0= No, 1= Yes
Age	SSB	Categorical	1=16-24; 25-44; 45-66; 0= 67+ (REF)
Gender	SSB	Dichotomous	1= Male, 0 =Female
Ethnicity	SSB	Dichotomous	1= Norwegian, 0 = Non Norwegian
Education	SSB	Dichotomous	1= Education High, 0= Education Low.
Private health insurance	SSB	Dichotomous	0= No, 1= Yes
Individual living in a municipality offering hospital care		Dichotomous	0= No, 1= Yes
Individual living in a municipality offering private specialists care		Dichotomous	0= No, 1= Yes
Access hospital beds		Continuous	
Access physician man-labor years		Continuous	
Access private specialists		Continuous	

Table 16. Variables used in the study.

7.3 Statistical Analysis

The aim of the statistical analysis is to allow us to test models to predict use of specialized health care. Since our outcome variables are dichotomous (0 = ***Non user** of specialized health care* versus 1= ***User** of specialized health care*) binary logistic regression is recommended[2] to estimate the probability of an event (*use of health care*) occurring. Our logistic model is

Prob (*User of specialized health care*) = $\frac{1}{1+e^{-z}}$

where Z = $B_0 + B_1X_1 + B_2X_2 + \ldots + B_pX_p$ and where p is the number of independent variables.

Or if written in terms of the log of the odds:

$$\ln\left[\frac{Prob\ (User)}{Prob\ (none\ user)}\right] = B_0 + B_1X_1 + B_2X_2 + \ldots + B_pX_p$$

The interpretation of the coefficients B in a logistic model is the change in the "log odds" as X changes, not very intuitive. A much more simple and intuitive measure is odds ratio. Using simple algebra we find that:

Odds ratio = $\frac{Prob\ (User)}{Prob\ (none\ user)} = exp^{B_0+B_1X_1+\ldots+B_pX_p}$

Exp (B_i) is the factor by which the odds ratio changes when the *i*th independent variable increase with one unit holding the other independent variable constant. Alternatively, we can express the results in terms of percent change in the odds ratio

Percent change = 100(*odds ratio* – 1)

where 1 indicates the amount of unit change in the independent variable. When describing the results, Exp (B_i), the 95 % confidence interval of the odds ratio and percent change in the odds ratio will be used. However, in order to make sence of these statistics an approppriate

[2] Logistic regression is recommended over linear regression because it is not possible for a binary variable to be normally distributed with a constant variance (heteroscedasticity) and consequently when determining the probability of the outcome variable results outside the interval 0-1 may occur (Norusis; 2008). Thus, the problem of impossible results is solved when using a loglinear analysis.

measurement scale for the independent variables must be used. As mentioned above, as a proxy for access to specialized health care we use the constructed accessibility indices for "*per head hospital beds*", "*per head physician man-labor years*" and "*per head private specialists*". However, if we use "per head" as a unit of access rather than access "per 10 000 residents", we will be estimating a relative change in odds "per head" change in access to specialized health care, which is so small that is hard to make sense out of it. Because of this we decided to refit the model using access to "Physician man-labor years per 10 000 residents" and "private specialists man-labor years per 10 000 residents". We will get the same p – values, but now the odds ratios are much easier to interpret.

We developed four consecutive models. Model 1 includes the need for care variables *self-assessed health* and *chronic illness* only. In model 2 we add the individual covariates *age*, *gender*, *ethnicity*, *education* and *household income* as non need indicators. Model 3 adds a dummy variable for individuals who have "*private treatment insurance*" and two area-level variables; a dummy variable for *individuals living in a municipality offering hospital services* and a dummy variable for *individuals living in a municipality offering private specialist care*. Finally, in model 4 we exclude the added variables in model 3 and include the accessibility indices for *physician man-labor years per 10 000 residents* and *private specialists man-labor years per 10 000 residents.* The two added variables in model 3 are excluded due to high intercorrelations, violating one of the assumptions in logistic regression. We also exclude in model 4 the accessibility indices for hospital beds for the same reason; strongly correlated with the other accessibility indices.

On condition holding need variables constant, if use varies with non- need variables, horizontal inequity exists (the unlike treatment of individuals with the same need). In other words, if the coefficients of the non- need variables are statistically significant from 0 $(B \neq 0)$.

When evaluating the performance of our logistic models, likelihood ratio testing is used to test the whether the coefficients excluded from the full model are 0. That is, a null hypothesis would be that none of the variables included in the model has an effect. For example, our model 2 contains six independent variables (*self-assessed health*, *chronic illness*, *age*, *gender*, *ethnicity* and *education*) and the model 1 contains only *self-assessed health* and *age,* then we are testing the null hypothesis that the coefficients for *age*, *gender ethnicity* and *education* are 0. This is referred to as 'model chi-square' because likelihood ratio testing has a chi – square distribution with k degrees of freedom, where k is the difference between the number of independent variables in the two models. The Likelihood ratio is defined as

Likelihood ratio = -2LL(reduced model) – (-2LL(full model))

For practical reasons -2 times the log likelihood (-2LL) is used as a measure of the predictive power of the model. A good model is one with small value for -2LL. If the computed change in -2 log likelihood is larger than the critical values of the chi – square distribution with k degrees of freedom, than **the predictive power of all the variables in the full model, after adjusting for all the variables in the reduced model is significant**. We also use the likelihood ratio test to compare model 1 against a model consisting of a constant term only. The likelihood ratio test statistics are calculated in the appendix. Since likelihood testing requires nested models we do not compare model 3 and 4 against each other. In the appendix we also include the McFadden's likelihood ratio test index $LRI = 1 - \frac{-2LL\ full\ model}{-2LL\ reduced\ model}$. The test is interpreted as the proportional reduction in –2LL and increases as the fit improves.

8. Results

Descriptive statistics for the variables included in the logistic regression are presented in table 17. Overall, 36.4% reported that they have *very good health*, 44.3 % state that they have *good health* while 6.0% reported of having *very bad* or *bad health*. Furthermore, 40.2 percent reported of having *chronic illness*. *Residents living within a municipality offering a hospital* accounted for 53.2% while 72.7% of *the respondents where living within a municipality offering private specialists care.*

We see from table 17 that during the previous 12 months 10.4 % reported at least one *hospital inpatient stay*, 26.9 % reported at least one *hospital outpatient visit* and 19.9 % reported at least one visit to *private specialist health care*. Moreover, table 17 indicates that the *chronically ill* and people with *very bad* and *bad health* are more opt to use specialist health care. It also indicates that overall, *females* and *highly educated* report more visits to specialized health care. Finally, people holding a *private insurance* seems to make more use of hospital inpatient services and *residents living within a municipality offering hospital care* are more opt to use the private specialist health care. In the next section we explore whether these differences are significant and still persist after controlling for need for care factor.

Table 17. Descriptive statistics.

Variables	**Total (%)**	**Hospital Inpatient (%)**	**Hospital Outpatient (%)**	**Private specialists (%)**
Overall	6465	672 (10.4)	1740 (26.9)	1285 (19.9)
Predisposing characteristics				
Age				
16-24	883 (13.7)	68 (10.1)	186 (10.7)	110 (8.6)
25-44	2222 (34.4)	239 (35.6)	514 (29.6)	415 (32.3)
45-66	2396 (37.1)	219 (32.6)	727 (41.8)	520 (40.5)
67 +	953 (14.7)	145 (21.6)	312 (17.9)	240 (18.7)
Gender				
Male	3172 (49.1)	293 (43.6)	752 (43.2)	487 (37.9)
Female	3293 (50.9)	379 (56.4)	988 (56.8)	798 (62.1)
Ethnicity				
Non Norwegian	454 (7.0)	37 (5.5)	111 (6.4)	93 (7.3)
Norwegian	5986 (92.6)	631 (94.5)	1622 (93.6)	1187 (92.7)
Education				
Education Low	4075 (63.0)	427 (67.0)	1106 (66.4)	758 (62.0)
Education High	2030 (31.4)	210 (33.0)	559 (33.6)	465 (38.0)
Household Income				
Household Income Low	3374 (52.5)	396 (59.1)	961 (55.3)	668 (52.1)
Household Income High	3056 (47.5)	274 (40.9)	776 (44.7)	613 (47.9)
Need for care factors				
Self-assessed health				
Very good health	2355 (36.4)	165 (24.6)	407 (23.4)	369 (28.7)
Good health	2865 (44.3)	269 (40.1)	771 (44.3)	585 (45.5)
Fair health	841 (13.0)	134 (20.0)	337 (19.4)	210 (16.3)
Bad and very bad health	391 (6.0)	103 (15.4)	225 (12.9)	121 (9.4)
Chronic illness				
No	3856 (59.6)	286 (42.6)	730 (42)	618 (48.1)
Yes	2597 (40.2)	386 (57.4)	1010 (58)	666 (51.9)
Enabling characteristics				
Private health insurance				
No	5826 (90.1)	609 (91.6)	1603 (93.4)	1170 (92.3)
Yes	509 (7.9)	56 (8.4)	114(6.6)	98 (7.7)
Residents living within a municipality offering hospital care				
No	3003 (46.5)	326 (48.8)	836 (48.2)	538 (41.9)
Yes	3440 (53.2)	342 (51.2)	897 (51.8)	745 (58.1)
Residents living within a municipality offering private specialists care				
No	1741 (26.9)	194 (29.0)	507 (29.3)	303 (23.6)
Yes	4702 (72.7)	474 (71.0)	1226 (70.7)	980 (76.4)
	Mean (Std.)			
Access indices physician man-labor years per 10 000 residents	19.3370 (15.7)			
Access indices private physician man labor years	1.026 (0.498)			

Model 1: ***Need for care variables***

In model 1 we only include the need for care variables *self-assessed health* and *chronic illness*. For the use of *hospital inpatient stay* and hospital *outpatient visit* the table 18 shows that the worse the *self assessed health* is, the higher is the probability of a *hospital inpatient stay* and *hospital outpatient visit*. The estimated coefficients are significant at 1 % level. The odds ratio for *very good health* on use of hospital inpatient stay is 0.284, or if inverted it, 3.5211. This is done to aid interpretation. This tells us that the odds on use of *hospital inpatient stay* are about 3.5211 times greater in the *very bad/bad* health group than in *very good health* group assuming that all the other factors are hold constant.

For the use of private specialists visit the model shows that both *very good health* (significant at 1%) and *good health* (significant at 10%) contributes negatively when compared to *very bad/ bad health*. Compared to persons with *very bad and bad health*, the odds of persons in the very good health group making use of *private specialists visit* decreases by a factor 0.637. People reporting *fair health* is not found to influence the use of *private specialists*.

People suffering from a *chronic illness* have a higher probability of a *hospital inpatient stay*, *hospital outpatient visit* and *private specialist visits* (significant at 1%). Given the odds ratio for *chronic illness* on *hospital outpatient stay*, having a *chronic illness* increased the odds of being a user by a factor of 1.975 compared to those with *no chronic illness*. The confidence limit is 1.733 to 2.250, which tells us that even after allowing for sampling error, the estimated odds will increase by at least 73% for people *suffering from a chronic illness*.

The likelihood ratio test in model 1 gives us an overall indication of how well the model performs compared to a model with the constant term only. The null hypothesis in a likelihood ratio test is that the coeffisients of the new variables included in model 1 are equal to 0. From the results above, most of the needs of care variables included in model 1 have an influence on use of specialized health care. That is, coefficients differ significantly from 0 ($B \neq 0$) . Hence, we most likely will end up rejecting the null hypothesis. The -2 log likelihood value in our model 1 on *hospital inpatient stay* is 3853.56 , the change in -2 log likelihood is 149.52 and is significant at 5% (for calculations see appendix). Therefore, we reject the null hypothesis and conclude that model 1 is a better predictor of *hospital inpatient use* compared to a model without any variables. The null hypothesis in a likelihood ratio tests is also rejected in the case of hospital *outpatient visit* and *private specialists visit* (significant at 5%).

Model 1	Hospital inpatient			Hospital outpatient			Private specialists		
	β	Exp (β)	95% CI Exp (β)	β	Exp (β)	95% CI Exp (β)	β	Exp (β)	95% CI Exp (β)
Constant	-1.455***	0.233		-0.322***			-1.302***	0.272	
Perceived health									
Very good health	-1.257***	0.284	(0.208-0.389)	-1.390***	0.249	(0.194-0.320)	-0.451***	0.637	(0.486-0.835)
Good health	-0.998***	0.369	(0.279-0.487)	-0.948***	0.388	(0.307-0.489)	-0.248*	0.780	(0.607-1.003)
Fair health	-0.564***	0.569	(0.421-0.768)	-0.548***	0.558	(0.433-0.718)	-0.173	0.841	(0.638-1.108)
Bad and very bad health	REF			REF			REF		
Chronic illness	0.452***	1.571	(1.297-1.903)	0.680***	1.975	(1.733-2.250)	0.475***	1.608	(1.394-1.855)
-2 log likelihood	3853.567***			6583.913***			5906.032***		
McFadden R^2	0.046953158			0.06211825			0.01598540		

Table 18. **The estimated effect of need for care variables on the probability of at least one contact with hospital inpatient, hospital outpatient and private specialists health care the previous 12 months.**

Model 2

In model 2 we add the individual covariates *age*, *gender*, *ethnicity*, *education* and *household income*. We see from table 19, that there is no change from model 1 regarding the effects of *self assessed health* on *hospital inpatient*. We also find that people with *chronic illness* more opt to use *hospital inpatient stay*. The odds ratio is 1.553, indicating that having a chronic *illness* increases the odds on use of *hospital inpatient stay* by a factor 1.533 compared to those *without any chronic illness* (significant at 1%). People in the *age group 45- 66* contributes negatively to the probability of a *hospital inpatient stay* compared to the *"67 +" age group* (significant at 1%). The odds on use of hospital inpatient stay are about 1.61 times greater in the *"67 +" age group* than in *"45-66" group*. Being a *male* affects the probability of a *hospital inpatient stay* negatively (significant at 5%), while *high education* contributes positively to a *hospital inpatient stay* (significant at 10%). Finally, being a *Norwegian* increases the odds of *hospital inpatient stay* by a factor of 1.774 (significant at 5%).

Regarding *hospital outpatient visit*, the worse the *self assessed health* is, the higher is the probability of a *hospital outpatient visit* (significant at 1 %). This shows similar results as model 1. The odds of a person making use of *hospital outpatient* services are 1.938 times higher for *persons suffering from chronic illness* (significant 1%). People in the *age 25- 44* have a lower probability for *hospital outpatient visit* compared to *"67 + " age group* (significant 10 %). The odds on use of a *hospital outpatient visit* are about 1.314 times greater for *female* (significant at 1%). Finally, the odds of a *hospital outpatient visit* are 1.26 times for *highly educated people.*

In model 2 regarding *private specialist visit*, *fair health* still has no influence on the probability of a *visit to a private specialist*. The odds of a person *visiting a private specialist* are 1.543 times higher for *person suffering from chronic illness* (significant at 1%). The *younger age group* is, the lower is the probability of a *private specialists visit*. The estimated results for the age group *16-24*, *25-44*, *45-66* are significant at 1 %. Being a *male* affects the probability of a *private specialists visit* negatively, while the odds on *a visit to a private specialists* for *highly educated* (significant at 1 %) and people with *high household income* (significant at 5 %) are 1.363 and 1.156 respectively.

We tested model 2 for its predictive power using likelihood ratio testing. We test the null hypothesis that the coefficients of the term that are excluded from model 2 are 0. That is, the null hypothesis that the coefficients for age, gender, ethnicity, education and household income are 0. We see from the appendix that the large difference in -2 log likelihood between model 1 and 2 is significant at 5 % level. Thus, the *use of specialists health care* is significantly associated with the added variables in model 2. The increase of the McFadden's likelihood ratio index also indicates that model 2 is superior to model 1.

Model 2	Hospital inpatient			Hospital outpatient			Private specialists		
	β	Exp (β)	95% CI Exp (β)	β	Exp (β)	95% CI Exp (β)	β	Exp (β)	95% CI Exp (β)
Constant	-1.680***	0.290		-0.233	0.792		-0.781***	0.458	
Perceived health									
Very good health	-1.332***	0.264	(0.191-0.366)	-1.432***	0.239	(0.184-0.309)	-0.481***	0.618	(0.468-0.819)
Good health	-1.034***	0.356	(0.267-0.473)	-0.966***	0.381	(0.301-0.482)	-0.251*	0.778	(0.602-1.006)
Fair health	-0.577***	0.561	(0.414-0.760)	-0.595***	0.552	(0.482-0.711)	-0.180	0.835	(0.632-1.105)
Bad and very bad health	REF			REF			REF		
Chronic illness	0.440***	1.553	(1.279-1.886)	0.662***	1.938	(1.698-2.212)	0.434***	1.543	(1.333-1.785)
Age :									
16-24	-0.258	0.772	(0.552-1.080)	-0.094	0.910	(0.715-1.158)	-0.637 ***	0.529	(0.4- 0.698)
25-44	-0.079	0.924	(0.720-1.185)	-0.167*	0.846	(0.700-1.022)	-0.351***	0.704	(0.576-0.861)
45-66	-0.477***	0.621	(0.486-0.792)	-0.014	0.986	(0.825-1.179)	-0.243***	0.784	(0.648-0.949)
67 +	REF			REF			REF		
Male	-0.187**	0.830	(0.701-0.983)	-0.273***	0.761	(0.676-0.858)	-0.527 ***	0.590	(0.518-0.673)
Norwegian	0.573**	1.774	(1.112-2.829)	0.036	1.037	(0.790-1.361)	-0.164	0.848	(0.639-1.126)
Education high	0.178*	1.195	(0.986-1.448)	0.231***	1.260	(1.101-1.442)	0.310***	1.363	(1.180-1.573)
Household income high	-0.052	0.950	(0.789-1.143)	0.065	1.067	(0.938-1.214)	0.145**	1.156	(1.004-1.331)
-2 log likelihood	3815.138***			6545.237***			5791.038***		
McFadden R^2	0.046953158			0.067627666			0.03514475		

Table 19. The estimated effect of need for care variables and individual covariates on the probability of at least one contact with hospital inpatient, hospital outpatient and private specialists health care the previous 12 months.

Model 3

In model 3 we add a dummy variable for *persons holding a private insurance*, a dummy variable for *individuals living within a municipality offering hospital care* and a dummy variable for *individuals living within a municipality offering private specialists care*. In model 3, the reference individual has *very bad/bad health*, *female*, *aged "67 +"*, *non- Norwegian*, *low educated*, *household income low*, not *holding a private insurance*, not *living within a municipality offering hospital care and private specialist care*. The results of the logistic regression are presented in table 20.

Regarding *hospital inpatient stay*, the worse the *self assessed health is*, the higher is the probability of a *hospital inpatient stay* (significant at 1 %). *Chronic illness* still has a positive influence on the probability of a *hospital inpatient stay* (significant at 1 %). People *aged 45-66* still has lower probability of a *hospital inpatient stay* (significant at 1 %). Being a *male* affects the probability of a *hospital inpatient stay* negatively (significant at 1 %), while being a *Norwegian* and *highly educated* contribute positively to a *hospital inpatient stay* (significant 5 %). This shows similar results as model 2. Finally, individuals holding a private insurance increase the odds of a *hospital inpatient stay* by a factor of 1.403 compared to individuals with *no private insurance* (significant at 5%). The two area level variables included have no influence on *hospital inpatient stay*.

With reference to *hospital outpatient visit*, the worse the *self assessed health* is, the higher is the probability of a *hospital outpatient visit* (significant at 1 %). People in the *age group 25-44* still have lower probability of a *hospital outpatient visit* compared with *"67 +" age group* (significant at 1 %). Being *male* contributes negatively to a *hospital outpatient visit* (significant at 1 %) while people with *high education* have a higher probability of *hospital outpatient visit* (significant at 1%). For *highly educated* people the odds of a *hospital outpatient* visit increase by a factor of 1.289 (or 28.9%) compared to person with *low education*. People living in *a municipality offering hospital care* and/or *private specialists care* is not found to influence the *use of hospital outpatient visit*.

Regarding *private specialist visit*, *very good* and *good health* contributes negatively to a *private specialists visit* compared to *very bad/bad health*; significant at 1 % and 5 % levels respectively. People with *fair health* is not found to influence the use of *private specialist visit* when compared to people with *very bad/bad health*. The variable *age* contributes negatively to a *private specialist visit*. That is, the *younger age group* is, the lower is the probability of a *private specialist visit* when compared to *"67 + " age group.* The estimated results for the *age group 16-24, 25-44, 45-66* are significant at 1 %. *Males* have a significantly (1%) lower probability of *visiting a private specialist*. We also find that *highly educated* individuals and people with *high household income* contribute positively to a *private specialist visit*; significant at 1% and 10% respectively. This is the same results shown in model 2. Finally, we find that for *residents living within a municipality offering hospital care*, the odds of a *private specialist visit* increase by a factor of 1.172 compared to *residents not living within a municipality offering hospital care,* all other factors being equal. *Residents living within a municipality offering private care* and *privately insured persons* did not influence the *use of private specialist care*.

We tested model 3 for its predictive power using likelihood ratio testing. We test the null hypothesis that the coefficients for the three added variables in model 3 are 0 and hence not associated with use of specialist care. We see from the appendix that regarding *private specialist visit*, the change in -2 log likelihood between model 2 and 3 is significant at 5 % level. Thus, we reject the null hypothesis. However, with reference to *hospital inpatient stay* and *hospital outpatient visit* we fail to reject the null hypothesis at 5 % significant level. This indicates that the partial model (model 2) is superior to the full model of overall model fit. The coefficients on the *private insurance* and *area level variables* are not statistically at standard levels.

Model 3	Hospital inpatient			Hospital outpatient			Private specialists		
	β	Exp (β)	95% CI Exp (β)	β	Exp (β)	95% CI Exp (β)	β	Exp (β)	95% CI Exp (β)
Constant	-1.278***	0.279		-0.117	0.890		-0.930***	0.395	
Perceived health									
Very good health	-1.346***	0.260	(0.188-0.361)	-1.423***	0.241	(0.186-0.312)	-0.500***	0.606	(0.458-0.802)
Good health	-1.047***	0.351	(0.263-0.467)	-0.963***	0.382	(0.302-0.483)	-0.262**	0.770	(0.595-0.995)
Fair health	-0.586***	0.557	(0.410-0.755)	-0.591***	0.554	(0.430-0.714)	-0.188	0.829	(0.626-1.096)
Bad and very bad health	REF			REF			REF		
Chronic illness	0.432***	1.540	(1.266-1.872)	0.666***	1.947	(1.705-2.224)	0.432***	1.540	(1.331-1.782)
Age :									
16-24	-0.281	0.755	(0.536-1.065)	-0.091	0.913	(0.717-1.163)	-0.651***	0.522	(0.395-0.689)
25-44	-0.104	0.901	(0.701-1.159)	-0.165*	0.848	(0.701-1.025)	-0.367***	0.693	(0.566-0.848)
45-66	-0.494***	0.610	(0.478-0.780)	-0.015	0.985	(0.824-1.178)	-0.249***	0.780	(0.644-0.944)
67 +	REF			REF			REF		
Male	-0.194**	0.824	(0.695-0.978)	-0.278***	0.758	(0.672-0.854)	-0.526***	0.591	(0.518-0.674)
Norwegian	0.594**	1.812	(1.122-2.925)	0.016	1.016	(0.773-1.335)	-0.133	0.875	(0.659-1.163)
Education high	0.196**	1.216	(1.000-1.480)	0.254***	1.289	(1.124-1.479)	0.276***	1.318	(1.139-1.525)
Household income high	-0.061	0.941	(0.780-1.135)	0.067	1.069	(0.939-1.217)	0.140*	1.150	(0.999-1.325)
Residents living within a municipality offering									
- hospital care	-0.039	0.962	(0.783-1.182)	-0.034	0.966	(0.837-1.116)	0.159**	1.172	(1.001-1.371)
- Private specialist care	-0.076	0.927	(0.739-1.162)	-0.127	0.880	(0.751-1.032)	0.076	1.079	(0.902-1.292)
Private Insurance	0.338**	1.403	(1.032-1.906)	0.001	1.001	(0.795-1.261)	0.161	1.174	(0.922-1.496)
-2 log likelihood	3809.560			6540.344			5780.292***		
McFadden R^2	0.04834658			0.068324677			0.036935169		

Table 20. The estimated effect of need for care variables , individual covariates and area level variables on the probability of at least one contact with hospital inpatient, hospital outaptient and private specialists health care the previous 12 months.

Model 4

In our last model (model 4) we exclude the three dummy variables added in model 3. Instead, we add two continuous variables; accessibility indices for specialized health care as measured by "*Physician man-labor years per 10 000 residents*" and "*private specialists man-labor years per 10 000 residents*". The results of the logistic regression are shown in table 22.

Regarding *hospital inpatient stay*, the worse the *self assessed health* is, the higher is the probability of a *hospital inpatient stay* (significant at 1 %). *Chronic illness* still has a positive influence on the probability of a *hospital inpatient stay* (significant at 1 %). People *aged 45-66* still have lower probability of a *hospital inpatient stay* (significant at 1 %). Being a *male* affects the probability of a *hospital inpatient stay* negatively (significant at 5 %), while being a *Norwegian* and *highly educated* contribute positively to a *hospital inpatient stay* significantly at 5% and 10% levels, respectively. This shows similar results as in model 2 and 3. Finally, the odds ratio for access to private specialist visit is 0.790. That tells us that for every extra "*private specialists man labor years per 10 000 residents*" provided, the odds *of hospital inpatient stay* decrease by a factor of 0.79 (or 21%), assuming that all other factors being equal. Accessibility measured by "*physician man-labor years per 10 000 residents*" is not found to influence the probability of a *hospital inpatient stay*.

With reference to *hospital outpatient visit*, the worse the *self assessed health* is, the higher is the probability of a *hospital outpatient visit* (significant at 1 %). People in the *age group 25-44* still have lower probability of a *hospital outpatient visit* compared with *"67 +" age group* (significant at 1 %). Being a *male* contributes negatively to a *hospital outpatient visit* (significant at 1 %) while people with *high education* have a higher probability of *hospital outpatient visit* (significant at 1%). For *highly educated* people the odds of a *hospital outpatient visit* increases by 1.302 (or 30.2%) compared to person with *low education*. This shows similar results as in model 2 and 3. Finally, the variable "*private specialists man labor years per 10 000 residents*" influences the probability for *a hospital outpatient visit* negatively. That is, for every extra "*private specialists man labor years per 10 000 residents*" provided, the odds of *hospital outpatient visit* decreases by a factor of 0.806 (or 19.4%) assuming that all other factors being equal. The added accessibility variable for public specialist health is not found to influence the use of *hospital outpatient visit*.

Regarding *private specialist visit*, people with *very good* and *good health* contribute negatively to a *private specialists visit* compared to people with *very bad/bad health*; significant at 1 % and 5 % respectively. People with *fair health* is not found to influence the use of *private specialist visit* when compared to people with *very bad/bad health.* The odds of a person *visiting a private specialist*, is 1.510 times higher for someone who suffers from *chronic illness* than for a person who does not suffer from chronic illnesses. The variable *age* contributes negatively to a private specialist visit. That is, the *younger age group* is, the lower is the probability of a *private specialists visit* compared to "*67 + " age group*. The estimated results for the *age* group *16-24*, *25-44*, *45-66* are significant at 1 %. *Males* have a significantly (1%) lower probability of *visiting a private specialists*. We also find that *high educated* individuals and people with *high household income* contributes positively to a private specialist visit; significant at 1% and 5% respectively. This is the same results as shown in model 2 and 3. Finally, the odds ratio for access to *private specialist visit* is 1.542. That tells us that for every extra "*private specialists man labor years per 10 000 residents* "offered, the odds of *private specialist visit* increases by a factor of 1.542 (or 54.2 %), assuming that all other factors being equal. Accessibility for "*physician man-labor years per 10 000 residents*" is not found to influence the probability of a *private specialist visit.*

We evaluated the performance of the model using likelihood ratio testing. We see from the appendix that regarding *hospital outpatient* and *private specialists visit* the change in -2 log likelihood in model 2 and 4 are significant at 5 % level. Thus, indicating that at least one of our accessibility indices is significantly associated with *hospital outpatient visit* and *private specialists visit*, even after adjusting for model 2 variables (need for care variables and individual covariates). The increase of the McFadden's likelihood ratio index also indicates that model 4 is superior to model 2. However, with reference to *hospital inpatient stay*, we fail to reject the null hypothesis at 5 % significant level.

Table 21 shows the overall results of the likelihood ratio testing significant at 5 %. A finding of significance, corresponds to the research conclusion that there is adequate fit of the data to our model compared to the *reference model*, indicating that at least one of the *added* predictors is significantly associated to use of specialized health care. Models that are not significant will be excluded from the further discussion.

	Hospital Inpatient Visit	**Hospital Outpatient Visit**	**Private Specialist Visit**
Model 1 (ref : model with a constant term only)	Significant	Significant	Significant
Model 2 (ref: model 1)	Significant	Significant	Significant
Model 3 (ref: model 2)	Not Significant	Not Significant	Significant
Model 4 (ref: model 2)	Not Significant	Significant	Significant

Table 21. The overall results of likelihood ratio testing, significant at 5 %.

Model 4	Hospital inpatient			Hospital outpatient			Private specialists		
	β	Exp (β)	95% CI Exp (β)	β	Exp (β)	95% CI Exp (β)	β	Exp (β)	95% CI Exp (β)
Constant	-1.468***	0.230		0.024	1.025		-1.358***	0.257	
Perceived health									
Very good health	-1.317***	0.268	(0.193-0.371)	-1.413***	0.243	(0.188-0.315)	-0.530***	0.589	(0.444-0.779)
Good health	-1.027***	0.358	(0.269-0.476)	-0.964***	0.382	(0.301-0.483)	-0.285**	0.752	(0.581-0.973)
Fair health	-0.571***	0.565	(0.417-0.765)	-0.579***	0.560	(0.435-0.722)	-0.196	0.822	(0.621-1.088)
Bad and very bad health	REF			REF			REF		
Chronic illness	0.449***	1.567	(1.291-1.904)	0.678***	1.971	(1.727-2.249)	0.412***	1.510	(1.305-1.746)
Age :									
16-24	-0.265	0.767	(0.548-1.074)	-0.115	0.891	(0.703-1.130)	-0.644***	0.525	(0.399-0.691)
25-44	-0.084	0.920	(0.716-1.180)	-0.179*	0.836	(0.692-1.010)	-0.354***	0.702	(0.574-0.858)
45-66	-0.480***	0.619	(0.485-0.790)	-0.021	0.980	(0.819-1.171)	-0.235*	0.791	(0.653-0.957)
67 +	REF			REF			REF		
Male	-0.188**	0.828	(0.699-0.982)	-0.287***	0.750	(0.666-0.845)	-0.532***	0.587	(0.515-0.670)
Norwegian	0.531**	1.701	(1.064-2.719)	-0.010	0.990	(0.754-1.300)	-0.026	0.975.	(0.734-1.295)
Education high	0.194*	1.214	(1.000-1.474)	0.264***	1.302	(1.137-1.492)	0.253***	1.288	(1.114-1.489)
Household income high	-0.050	0.951	(0.790-1.145)	0.076	1.079	(0.949-1.227)	0.154**	1.166	(1.013-1.342)
Access physician man labor years	0.003	1.003	(0.996-1.009)	0.000	0.999	(0.994-1.004)	0.002	1.002	(0.998-1.007)
Access to private specialists	-0.236**	0.790	(0.645-0.967)	-0.216***	0.806	(0.699-0.929)	0.433***	1.542	(1.318-1.805)
-2 log likelihood	3856.544			6613.726***			5819.53***		
McFadden R^2	0.048790709			0.0700005			0.044151765		

Table 22. The estimated effect of need for care variables , individual covariates and access to specialist health care on the probability of at least one contact with hospital inpatient, hospital outaptient and private specialists health care the previous 12 month.

9. Discussion and concluding remarks

In the Norwegian health care system equal distribution and access to care regardless of social status, gender, ethnicity and area of living has been raised as an important issue (Heggestad 2009). One of the key strengths of the Norwegian health care system is the equity objective of *equal use for equal need* (Johnsen 2006, The Act on Health Enterprises). This motivates to audit whether these policy statements in the Norwegian health care system are achieved. The aim of the present study falls into two parts. First, we are interested in whether the residents living in different municipalities in Norway have *equal access* to specialized health care irrespective of whether they live very close to a hospital and/or private specialists or whether they live in a remote area. Second, adapting an explorative approach, we investigate whether the policy statement on equity in the form of *equal use for equal need* (horizontal equity) in specialized health care is achieved. Specialized health care included in this study is hospital inpatient stay, hospital outpatient visit and private specialist visit. We consider this study to be helpful in identifying how fairly and just specialized health care is distributed and in developing future health policies.

For this purpose, we first develop accessibility indices for each municipality that incorporate both the capacity and the distance to specialized health care to address whether the principle of *equal access* to specialist health care is achieved. According to the results there is not equal access in the delivery of specialized health care in the Norwegian health care system. The result reveals that capital *Oslo* has the best access to specialist health care and the residents of northern Norway (*Finnmark county*) have the worst access. This indicates that access to specialized health care in Norway depends on where you live.

In part II of our study we take the study a step further and ask whether these inequalities in access might induce to the use of more (or less) specialist health care services (horizontal inequity). There is *horizontal inequity* if individuals with the same levels of need utilize different amount of specialized health care due to factors that ought not to affect use i.e. access to specialized health care. The analyses are organized as follows: we use the constructed accessibility indices in part 1 as a proxy for access to specialized health care for each municipality. We then link these indices with data on use of specialized health care, *self* *assessed health*, *chronic illness*, *gender*, *age*, *ethnicity* and *socio economic position* from 2008 Survey of Living Conditions by Statistics Norway, thereby combining individual data with a measurement of access to specialized health care, providing individual data about use, need, and access to specialized care. The determinants of horizontal inequity are analyzed using logistic regression.

A preliminary conclusion is that the use of hospital inpatient stay and hospital outpatient visit are both rationed by need. That is, the worse the *self assessed health* is, the higher is the probability of a *hospital inpatient stay* and a *hospital outpatient visit.* Hence, this result is in accordance with the stated equity objective. For the use of private specialists the results show that people reporting *very good health* and *good health* make less use of *private specialist* compared to *very bad and bad health*. People reporting *fair health* is not found to influence the use of *private specialists*. Even though, the use of private specialists was not as closely related to a person's self assessed health as in the case hospital inpatient stay and hospital outpatient visit this still represents a move in the right direction. Iversen and Kopperud (2002) using the 1998 Survey of Living Conditions by Statistics Norway did not find any effect of self assessed health on the utilization of private specialists. The effect of our second need variable, chronic illness, are both significant and plausible. People suffering from a *chronic illness* are associated with a higher probability of utilization of all three types of specialized care. The close association of chronic illness with *private specialist visits* indicates that regular check-ups of people suffering from chronic illness is an important task (Iversen and Kopperud, 2002).

For all three types of specialized health care, an individual's *age* and *gender* is associated with *use of specialists services*, after having controlled for self assessed health, chronic illness and socio economic variables. *Women* use more of all types of specialized health care, supporting earlier studies (Verbrugge et al., 1987). Several interpretations have been suggested: the differences in reproductive biology, higher rates of morbidity in women than men (Verbrugge et al. 1987) and that women are healthier but have worse perceptions of their health (Suominen-Taipale et al.; 2006). With respect to *age*, people *aged 45 to 66* had lower odds of a *hospital inpatient stay* than people in the age "*67+*". Compared with *"67+" age* groups, people in the age group 25-44 were less likely to have contacted hospital outpatient visit. Moreover, we find that the use of a private specialist visit is closely related to a person's age. We suggest that this effect is due to the people's perception of good health influenced by their age (Iversen and Kopperud 2002).

Our finding that Non-Norwegians were less likely to use hospital inpatient stay than Norwegians may indicate horizontal inequity if we believe that this is due to systematic discrimination of non Norwegians in use of hospital inpatient visit. We might expect that cultural differences may affect use i.e. long delays before contacting health care or denying recommended services. Self assessed health may be modified by culture (Jylha; 2009). For example, studies find that Italians rate their health more positively than Finns (Jylha et al., 1998) and the relation between symptoms as pain and self assessed health varies between cultures (Gureje, von Korff, Simon and Gater, 1998).

For all three types of specialized health care, individuals with *high education* were more likely to *use specialized health* care than individuals with *low education*, after having controlled for *self assessed health, chronic illness*, *gender*, *age* and *household income*. According to this result the equity objective, *equal use for equal need* is not achieved. We illustrate this by calculating the predicted probability of a hospital outpatient visit using self assessed health and educational level. Figure 4, shows that for all levels of need, high educated individuals have a higher probability in use of a hospital outpatient visit than people with low education. This may reflect better ability to communicate, obtain and understand basic health information ("health literacy") among highly educated. Individuals with low education might lack the ability to express their demand and to know their rights as patients causing an under consumption of specialized health care.

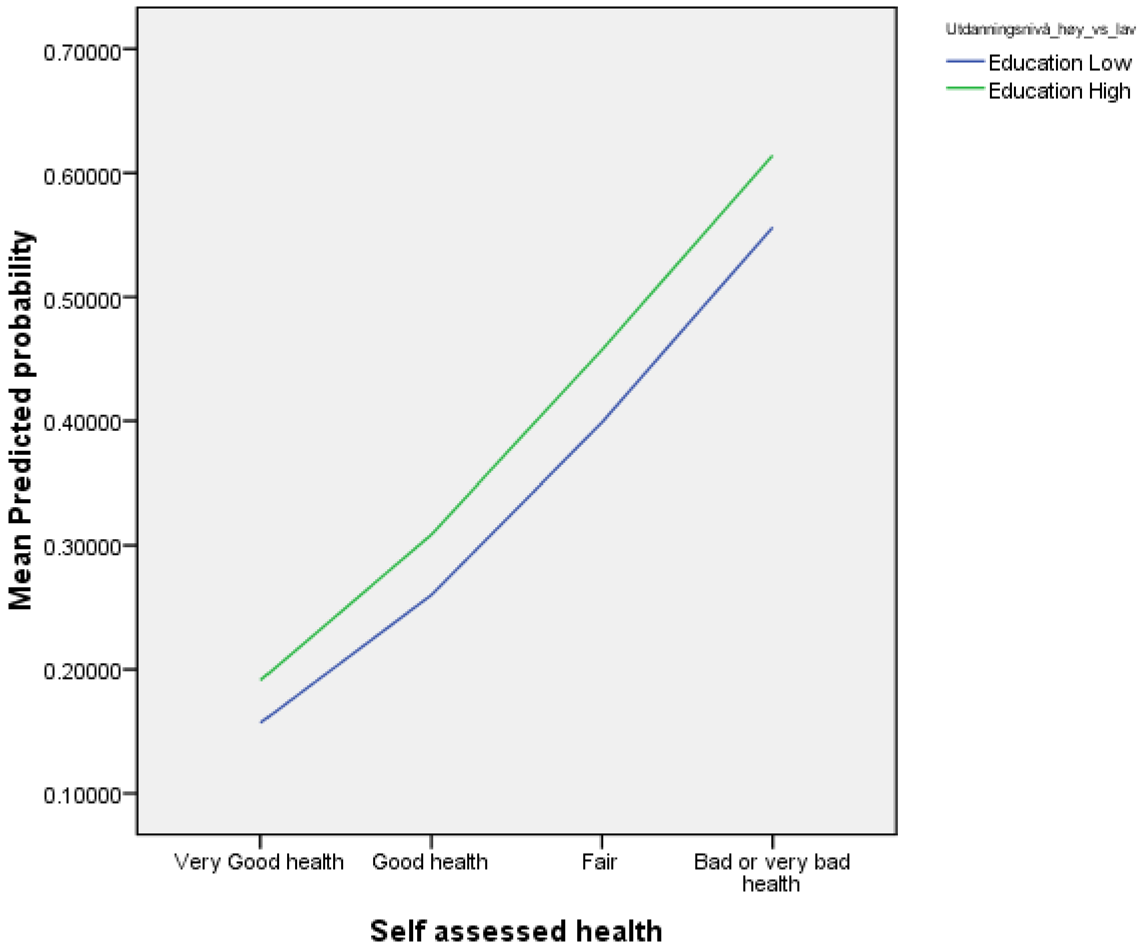

Figure 4. The mean predicted probability of a hospital outpatient visit by different self assessed health groups and by educational level.

We found *horizontal inequity* in use of private specialist visit favoring patients who are better off. Richer people (higher than mean income) are more likely to visit a private specialist than a person with low income. This may reflect the easy access to private specialist, since a patient does not need a referral to enter but on the other hand, has to pay the full cost of the treatment.

An unexpected result is that the *residents living within a municipality offering hospital care* are more likely to visit a private specialist compared to a *municipality not providing its residents with hospital care*. We also find that the high access of *living within a municipality offering private specialists* had no influence on a visit to *private specialist*. We expected a “supplier induced demand”; meaning that individuals might be ‘induced’ to use more health services in areas with significantly high provision of health. After checking for high intercorrelations among these two predictors, we found multicollinearity[3]. When the variable *living within a municipality offering hospital care* is disregarded, we find that for *residents living within a municipality offering private specialist*, the odds for private specialists visit increase by a factor of 1.195 (95 % C.I. 1.027-1.389) compared to *residents not living within a municipality offering private specialists* (significant at 5%). To illustrate this, figure 5 shows the predicted probability of a private specialist visit explained by self assessed health and the availability of private specialists. As expected, figure 4 shows that for all levels of need, people living in a municipality offering *private specialists* have a higher probability to contact a private specialists than people not living in a municipality offering private specialists care.

[3] It should be noted that our models are robust. Meaning that the consecutive inclusion of new variables has significant effect on the outcome variables and either the significance or sign of the previously introduced variables changed in a substantial way. This represents an ideal situation and indicates low correlation among the independent variables.

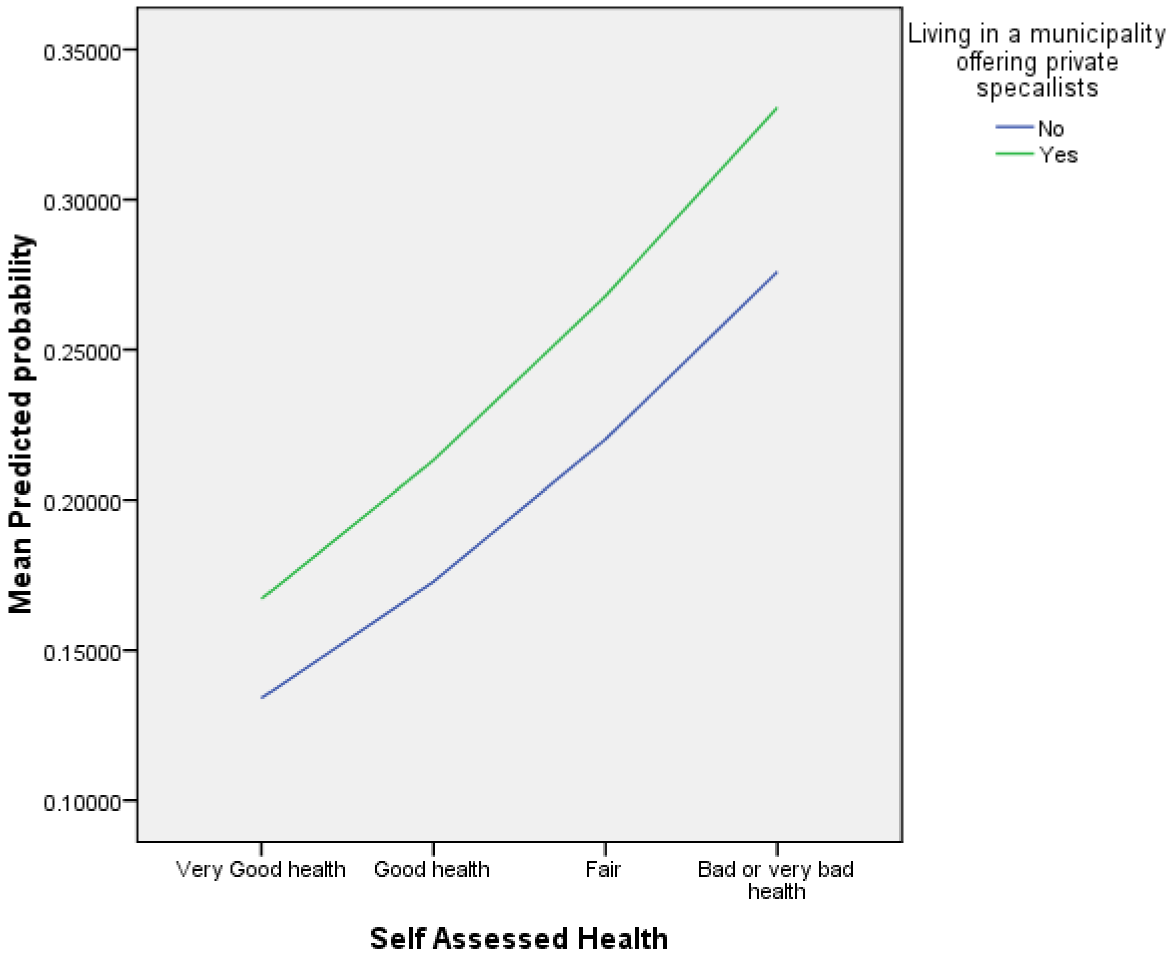

Figure 5. The mean predicted probability of a private specialist visit by different self assessed health groups and by access to private specialists.

This utilization is an indication of horizontal inequity since two individual's with the same health status should have the same probability of a private specialist visits irrespective of whether they live in a municipality offering private specialists or not. This demonstrates that the use of private specialist health care in Norway is also determined by easy access than by need. This conclusion is in accordance with Iversen and Kopperud (2002) who found that the better access to private specialists is, the higher is the probability of a private specialist. One possible explanation is that people living in areas with greater supply have lower access costs in the form of shorter distances or shorter waiting times due to greater individual net benefit (Morris et al., 2005).

The accessibility indices for specialist care have substantial effect on the utilization of private specialists and hospital outpatient. We found that the better access to private specialists is, the higher is the probability of a visit to a private specialist. This is just as expected. Regarding hospital outpatient we find that the better access to private specialists is, the lower is the probability of a visit to hospital outpatient clinic. This suggests that the use of a hospital outpatient visit is a possible substitute for private specialists. One possible explanation is that better access to private specialists leads to a higher opportunity for GPs to send their patient for consultation to private specialists (lower access costs for the patient). Moreover, individuals living in areas with high *access of private specialists* have the opportunity to contact a specialist directly with less access cost than an individual living in area with limited access to private specialists. This suggests horizontal inequity and represents a challenge for health policy makers to bring the publicly funded private specialists in line with the national health policy.

There are a number of limitations in our study. First, our utilization measures of use in health care are dichotomous (*user* versus *non user*) and there is no information on intensity or quality of specialized health care provided. Second, the measures of morbidity are based on self assessed health while the provision of a referral and access to specialist health care is based on the physician assessment of patient's health (Iversen and Kopperud 2002). Third, information obtained from the respondents may be subject to recall bias since use relates to the previous last twelve months. Finally, the study does not take into account the possible interactions of specialized health care. For example, a patient may have visited a hospital outpatient clinic or/and private specialist before a hospital inpatient stay.

These limitations aside, our results provide evidence on inequity in the delivery of specialized health care services in Norway. Our findings are evidence for inequity in use of *hospital inpatient stay* by *ethnicity* and *education,* in use of *hospital outpatient* visit by *education* and *access to private specialist* and in use of *private specialist visit* by *education*, *household income* and the *access to private specialists*. We consider this information to be helpful in identifying how fairly and just specialized health care are distributed and in developing future health policies.

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11. Appendix

Appendix A: An overview of regional health autiority, hospitals and catchment area.

Regional Health Authority	Hospital	Catchment area Municipalities	Residence in the catchment area
Central Norway			
	Helse Sunnmøre HF Volda Sjukehus	Giske, Haram, Hareid, Herøy, Norddal, Sande, Skodje, Stordal, Stranda, Sula, Sykkylven, Ulstein, Vanylven, Volda, Ørskog, Ørsta and Ålesund.	131 450
	Helse Sunnmøre HF Ålesund sjukehus	Giske, Haram, Hareid, Herøy, Norddal, Sande, Skodje, Stordal, Stranda, Sula, Sykkylven, Ulstein, Vanylven, Volda, Ørskog, Ørsta and Ålesund.	131 450
	Helse Nordmøre and Romsdal Kristiansund sykehus	Aukra, Fræna, Midsund, Molde, Nesset, Sandøy, Rauma, Vestnes, Aure, Averøy, Eide, Frei, Gjemnes, Halsa, Kristiansund, Rindal, Smøla, Sunndal, Surnadal and Tingvoll.	117 130
	Helse Nordmøre and Romsdal Molde sjukehus	Aukra, Fræna, Midsund, Molde, Nesset, Sandøy, Rauma, Vestnes, Aure, Averøy, Eide, Frei, Gjemnes, Halsa, Kristiansund, Rindal, Smøla, Sunndal, Surnadal and Tingvoll.	117 130
	St. Olavs sykehus. (Local level)	Sør- Trøndelag county with the exception of these municipalities: Nordland, Osen, Tydal and halve Malvik.	286 860
	St. Olavs sykehus (region level).	Central Norway region	666 270
	St. Olavs sykehus Orkdal Sjukehus	Sør- Trøndelag county with the exception of these municipalities: Nordland, Osen, Tydal and half of Malvik.	286 860
	St. Olavs hospital Røros	Sør- Trøndelag county with the exception of these municipalities: Nordland, Osen, Tydal and half of Malvik.	286 860

	Helse Nord- Trøndelag :Sykehuset Levanger	Nord- Trøndelag county including Bindal in Nordland og Osen, Selbu, Tydal og half of Malvik in Sør- Trøndelag	149 175
	Helse Nord- Trøndelag: Sykehuset Namsos	Nord- Trøndelag county including Bindal in Nordland og Osen, Selbu, Tydal og half of Malvik in Sør- Trøndelag	149 175

Regional Health Authority	**Hospital**	**Catchment area municipalities**	**Residence in the catchment area**
Northern Norway			
	Helgelandssykehuset Mo i Rana	Bindal, Sømma, Brønnøy, Vega, Vevelstad, Herøy, Alstadhaug, Leirfjord, Vefsn, Grane, Hattfjelldal, Dønna, Nesna, Hemnes, Rana, Lurøy, Træna, Rødøy.	76 920
	Helgelandssykehuset Mosjøen	Bindal, Sømma, Brønnøy, Vega, Vevelstad, Herøy, Alstadhaug, Leirfjord, Vefsn, Grane, Hattfjelldal, Dønna, Nesna, Hemnes, Rana, Lurøy, Træna, Rødøy.	76 920
	Helgelandssykehuset Sandnessjøen	Bindal, Sømma, Brønnøy, Vega, Vevelstad, Herøy, Alstadhaug, Leirfjord, Vefsn, Grane, Hattfjelldal, Dønna, Nesna, Hemnes, Rana, Lurøy, Træna, Rødøy.	76 920
	Helse Finnmark Klinikk Hammerfest	Finnmark county	72 435
	Helse Finnmark Klinikk Kirkenes	Finnmark county	72 435
	Longyearbyen Sykehus	Troms county including Narvik, Tysfjord, Lødingen, Tjeldslund, Evenes and Ballangen	183 635
	Nordlanssykehuset Bodø	Bodø, Meløy, Gildeskål, Beiarn, Saltdal, Fauske, Sørfold, Steigen, Hamarøy, Tysfjord- Vest for Tysfjorden, Røst, Værøy, Flakstad, Vestvågøy, Vågan, Moskenes, Hadsel, Bø, Øksnes, Sortland and Andøy	132 500
	Nordlandssykehuset Lofoten	Bodø, Meløy, Gildeskål, Beiarn, Saltdal, Fauske, Sørfold, Steigen, Hamarøy, Tysfjord- Vest for Tysfjorden, Røst, Værøy, Flakstad, Vestvågøy, Vågan, Moskenes, Hadsel, Bø, Øksnes, Sortland and Andøy	132 500
	Nordlandssykehuset Stokmarknes	Bodø, Meløy, Gildeskål, Beiarn, Saltdal, Fauske, Sørfold, Steigen, Hamarøy, Tysfjord- Vest for Tysfjorden, Røst, Værøy, Flakstad, Vestvågøy, Vågan, Moskenes, Hadsel, Bø, Øksnes, Sortland and Andøy	132500
	Universitetssykehuset Nord-Norge Harstad	Troms county including Narvik, Tysfjord, Lødingen, Tjeldslund, Evenes and Ballangen	183 635

	Universitetssykehuset Nord-Norge Narvik	Troms county including Narvik, Tysfjord, Lødingen, Tjeldslund, Evenes and Ballangen	183 635
	Universitetssykehuset Nord-land Tromsø. Local level.	Troms county including Narvik, Tysfjord, Lødingen, Tjeldslund, Evenes and Ballangen	183 635
	Universitetssykehuset Nord-Norge Trømsø. Region level.	Northern Norway region	463 450

Regional Health Authority	Hospital	Catchment area municipalities	Residence in the catchment area
Western Norway			
	Florø sjukehus	Not included. The hospital has focus on tasks of border between primary care and specialist health care. The hospials inpatient stay department is closed.	
	Førde sentralsjukehus	Flora, Gulen, Soulnd, hyllestad, Høyanger, Vik, Årdal, Askvoll, Fjaler, Gaular, Jølster, Førde and Naustdal.	106 485
	Helse Bergen HF. Local level.	Fedje, Øygarden, Fjell, Sund, Austevoll, Austheim, Radøy, Meland, Askøy, Bergen, Os, Masfjorden, Lindas, Osterøy, Samnanger, Fusa, Modalen, Vaksdal, Kvam, Voss , Granvin and Ulvik.	401 335
	Helse Bergen HF. Region level.	Western Norway region.	996 870
	Helse Fonna HF Haugesund sjukehus	The following municipalitites: Bokn, Haugesund, Karmøy, Tysvær, Utsira, Vindafjord, Etne, Sveio, Sauda and Suldal.	109 285
	Helse Fonna HF Odda sjukehus	Odda, Ullensvang, Eidfjord and Jondal	12 410
	Helse Fonna HF Sauda	Not included. Department Sauda is organized under Haugesund Hospital, surgical clinic. Offers daytreatment in surgery and urology.	
	Helse Fonna HF Stord sjukehus	Stord, Bømlo, Fitjar, Tysnes and Kvinnherad.	47 215
	Helse stavanger HF	South of Rogaland county: Søkndal, Lund, Eigersund, Bjerkreim, Hå, Time, Gjesdal, Klepp, Sandnes, Forsand, Stavanger, Sola, Randaberg Strandm Kvitsøy, Rennesøy, Hjelmeland and Finnøy.	320 140
	Kysthospitalet i Hagevik	Not included due to high degree of specialization.	
	Lærdal sjukehus	Indre Sogn: Aurland, Balestrand, Leikanger, Luster, Lærdal, Sogndal, Vik and Årdal.	19 230

	Nordfjord Sjukehus	The following municipalitites: Stryn, Hornindal, Eid, Gloppen, Vågsøy, Selje and parts of Bremanger.	32 360
	Voss Sjukehus	Kvam, Granvin, Ulvik, Voss, Vaksdal and Modalen.	28 720
	Haraldsplass Diakonale Sykehus	Borough: Bergenhus, Åsane og Arna i Bergen.Municipalities: Lindås, Meland, Radøy, Austrheim, Fedje, Masfjorden, Samnanger and Osterøy.	123 391
	Haugesund sanitetsforeningsrevmatisme sykehus	Not included in the study due to high degree of specialization. Provides services within skin diseases and rheumatism.	

Regional Health Authority	Hospital	Catchment area muncipalities	Residence in the catchment area
Southern and Eastern Norway			
	Sykehuset Asker og Bærum	Asker og Bærum	163 580
	Sykehuset buskerud	Drammen, Nedre Eiker, Lier, Røyken and Hurum.	134 440
	Sykehuset i Vestfold Larvik	Vestfold county	229 280
	Sykehuset i vestfold Sandefjord	Vestfold county	229 280
	Sykehuset i vestfold i Tønsberg	Vestfold county	229 280
	Sykehuset innlandet Elverum	Engerdal, Trysil, Åmot, Ringsaker, Hamar, Løten, Elverum, Stange, Våler and Åsnes.	130 510
	Sykehuset innlandet Hamar	Engerdal, Trysil, Åmot, Ringsaker, Hamar, Løten, Elverum, Stange, Våler and Åsnes.	130 510
	Sykehuset innlandet Gjøvik	Vang, Vestre Slidre, Nord Aurdal, Sør- Aurdal, Øystre slidre, Etnedal, Nordre land, Gjøvik, Vestre toten, Østre Toten, Sørdre Land, Gran, Jevnaker and Lunner.	114 325
	Sykehus innlandet divisjon kongsvinger	Nord Odalm Grue, Sør- Odal, Eidskog, kongsvinger and Nes in Akershus county.	60 355
	Sykehus innlandet Divisjon Lillehammer	Lesja, Skjåk, Lom, Dovre, vågå, Nord- fon, Sel, Sør-fon, ringebu, Øyer, Gausdal and lillehammer.	70 070
	Sykehus innlandet divisjon Tynset	Os, Tolga, Tynset, folldal, Alvdal, Rendalen and Stor-Elvdal	17 870
	Sykehus innlandet Granheim Lungesykehuset	Not included in the study due to high degree of specialization.	
	Sykehuset Telemark Skien	Porsgrunn, Skien, Siljan, Bamble, Kragerø. Drangedal, Nissedal og Fyresdal.	119 930

Sykehuset Telemark Kragerø sykehus	Porsgrunn, Skien, Siljan, Bamble, Kragerø. Drangedal, Nissedal and Fyresdal.	119 930
Sykehuset Østfold avd. Askim	Østfold county.	267 915
Sykehuset Østfold avd. Fredrikstad	Østfold county.	267 915
Sykehuset Østfold avd. Halden	Østfold county.	267 915
Sykehuset Østfold avd. Moss	Østfold county.	267 915
Sykehuset Østfold avd. Sarpsborg	Østfold county.	267 915
Sørlandet sykehus HF Arendal	Aust-Agder county	107 430
Sørlandet sykehus HF Flekkefjord	Vest-Agder county	168 225
Sørlandet sykehus HF kristiansand	Vest-Agder county	168 225
Diakonhjemmet sykehus	The following boroughs in Oslo: Vestre Aker, Ullern and Frogner.	121 653
Martina Hansens hospital	Not included in the study due to high degree of specialization.	---------
Revmatisme sykehuset Lillehammer	Not included in the study due to high degree of specialization.	---------
Betanien hospital	Not included in the study due to high degree of specialization.	---------
Spesialsykehuset for rehabilitering Stavern	Not included in the study due to high degree of specialization.	---------

Regional Health Authority	Hospital	Catchment area muncipalities	Residence in the catchment area
Southern and Eastern Norway			
	Akershus universitetssykehus	Gjerdrum, Ullensaker, Nannestad, Eidsvoll, Nes, Hurdal, Aurskog-Høland, Enebakk, Fet, Lørenskog, Nittedal, Rælingen, Sørum og Skedsmo. Samt kommunene Rømskog og Enebakk. Bydeler i Oslo: Grorud and Stovner.	288 271
	Blefjell sykehus kongsberg	Kongsberg, Nore og Uvdal, Sigdal, Rollag, Flesberg and Øvre Eiker.	50765
	Blefjell sykehus Notodden	Bø, Hjartdal, Nome, Notodden, Kviteseid, Sauherad and Seljord.	35735
	Blefjell sykehus Rjukan	Tinn, Tokke and Vinje.	12020
	Epilepsisenteret - SSE	Not included in the study due to high degree of specialization.	
	Hjertesenteret i Oslo	Not included in the study due to high degree of specialization.	
	Lovisenberg Diakonale sykehus AS	The following boroughs in Oslo: St. Hanhaugen, Grunerløkka, Sagene and Gamle Oslo.	150 594
	Oslo Universitetssykehus Aker	The following boroughs in Oslo : Bjerke and Alna. Municipalities: Ski, Oppegård, Nesodden, Ås, Frogn and Vestby.	159 829
	Oslo Universitetssykehus Rikshospitalet. Local level.	The following boroughs in Oslo Frogner, Ullern og vestre Aker.	121 653
	Oslo Universitetssykehus Rikshospitalet. National responsibility.	National responsibility.	4 801 055
	Oslo universitetssykehus Ullevål fylkesfunksjon	The following boroughs in Oslo : Sagene, Nordre Aker, Østensjø, Norstrand and Søndre Norstrand.	171 034
	Oslo Universitetssykehus Ullevål Regionfunksjon	SouthEastern region.	3 671 335
	Ringerike sykehus	Ringerike, Hole, Flå, Gol, Hemsedal, Ål, Hol, Krødsherad and Modum.	66150
	Stensby sykehus	Nannenstad, Hurdal, Eidsvoll, Ullensaker and Nes.	80505
	Sunnaas sykehus	Not included in the study due to high degree of specialization. .	

Appendix B:

Hospital effective beds 2007 data:

	Effective beds
TOTAL NUMBER OF EFFECTIVE BEDS	13553
Healthregion Sothern and Eastern Norway TOTAL	7382
Aker universitetssykehus	343
Akershus Universitetssykehus	496
Bærum sykehus	254
Diakonhjemmet sykehus	188
Granheim lungesenter	40
Kongsvinger sjukehus	124
Lovisenberg diakonale sykehus	181
Martina Hansens hospital	75
Oppland sentralsykehus, avd. Gjøvik	201
Oppland sentralsykehus, avd. Lillehammer	250
Revmatismesykehuset AS	48
Sentralsjukehuset i Hedmark	332
Ski sykehus	0
Stensby sykehus	68
Sunnaas sykehus	148
Sykehuset Innlandet Tynset	51
Sykehuset Østfold	497
Ullevål universitetssykehus	772
Betanien Hospital	52
Det Norske Radiumhospital	0
Hjertesenteret i Oslo	0
Kongsberg sykehus	103
Kongsgård sykehus	0
Kragerø sykehus	51
Notodden sykehus	51
Rikshospitalet - Radiumhospitalet	931
Ringerike sykehus	144
Rjukan sykehus	37
Spesialsykehuset for epilepsi	0
Spesialsykehuset for rehabilitering Stavern	110
Sykehuset Buskerud	404
Sykehuset i Vestfold	426
Sykehuset Telemark	405
Sørlandet sykehus Arendal	240
Sørlandet sykehus Flekkefjord	65
Sørlandet sykehus Kristiansand	188
HEALTHREGION WESTERN NORWAY	2552
Førde sentralsjukehus	188
Haraldsplass Diakonale Sykehus AS	175
Haugesund sanitetsforenings revmatisme sykehus	44
Haugesund sjukehus	223
Haukeland universitetssjukehus	975
Lærdal sjukehus	54
Nordfjord sjukehus	53
Odda sjukehus	46
Stavanger universitetssjukehus	634

Stord sjukehus	83
Voss sjukehus	77
HEALTHREGION CENTRAL NORWAY	1834
Kristiansund sykehus	101
Molde sjukehus	178
Orkdal sjukehus	0
St Olavs Hospital	878
Sykehuset Levanger	203
Sykehuset Namsos	107
Volda sjukehus	67
Ålesund sjukehus	300
HEALTHREGION NORTHERN NORWAY	1539
Hammerfest sykehus	102
Harstad sykehus	103
Helgelandssykehuset Mo i Rana	95
Helgelandssykehuset Mosjøen	33
Helgelandssykehuset Sandnessjøen	78
Kirkenes sykehus	61
Longearbyen sykehus	7
Narvik sykehus	71
Nordlandssykehuset Lofoten	52
Nordlandssykehuset Sentrum	340
Nordlandssykehuset Vesterålen	88
Stokmarknes sykehus	0
Universitetssykehuset i Nord-Norge	509

Appendix B:
Physician man labor years 2007 data:

	Physician Man-labor years
TOTAL NUMBER OF PHYSICIAN MAN-LABOR YEARS:	8640
HEALTHREGION SOUTHERN AND EASTERN NORWAY	4765
Aker universitetssykehus	238
Akershus Universitetssykehus	400
Bærum sykehus	139
Diakonhjemmet sykehus	107
Granheim lungesenter	4
Kongsvinger sjukehus	54
Lovisenberg diakonale sykehus	76
Martina Hansens hospital	33
Oppland sentralsykehus, avd. Gjøvik	121
Oppland sentralsykehus, avd. Lillehammer	152
Revmatismesykehuset AS	14
Sentralsjukehuset i Hedmark	230
Ski sykehus	0
Stensby sykehus	14
Sunnaas sykehus	32
Sykehuset Innlandet Tynset	24
Sykehuset Østfold	340
Ullevål universitetssykehus	785
Betanien Hospital	18
Det Norske Radiumhospital	0
Hjertesenteret i Oslo	0
Kongsberg sykehus	50
Kongsgård sykehus	0
Kragerø sykehus	6
Notodden sykehus	23
Rikshospitalet - Radiumhospitalet	754
Ringerike sykehus	71
Rjukan sykehus	9
Spesialsykehuset for epilepsi	0
Spesialsykehuset for rehabilitering Stavern	23
Sykehuset Buskerud	235
Sykehuset i Vestfold	278
Sykehuset Telemark	189
Sørlandet sykehus Arendal	118
Sørlandet sykehus Flekkefjord	26
Sørlandet sykehus Kristiansand	203
HEALTHREGION WESTERN NORWAY TOTAL	1616
Førde sentralsjukehus	151
Haraldsplass Diakonale Sykehus AS	80
Haugesund sanitetsforenings revmatisme sykehus	16
Haugesund sjukehus	166
Haukeland universitetssjukehus	708
Lærdal sjukehus	0
Nordfjord sjukehus	0
Odda sjukehus	17
Stavanger universitetssjukehus	411
Stord sjukehus	39
Voss sjukehus	30

HEALTHREGION CENTRAL NORWAY TOTAL	1157
Kristiansund sykehus	59
Molde sjukehus	108
Orkdal sjukehus	0
St Olavs Hospital	595
Sykehuset Levanger	111
Sykehuset Namsos	57
Volda sjukehus	37
Ålesund sjukehus	190
HEALTHREGION NORTHERN NORWAY TOTAL	1008
Hammerfest sykehus	57
Harstad sykehus	71
Helgelandssykehuset Mo i Rana	42
Helgelandssykehuset Mosjøen	30
Helgelandssykehuset Sandnessjøen	43
Kirkenes sykehus	35
Longearbyen sykehus	3
Narvik sykehus	30
Nordlandssykehuset Lofoten	21
Nordlandssykehuset Sentrum	197
Nordlandssykehuset Vesterålen	28
Stokmarknes sykehus	0
Universitetssykehuset i Nord-Norge	458

Appendix C

The number of contracted private specialists measured in man-labor years by municipal.

Mucipality	Man-labor years
Halden	4.2
Moss	9.2
Sarpsborg	11.2
Fredrikstad	20.8
Spydeberg	0.2
Askim	0.8
Råde	1
Rygge	0.2
Våler	0.2
Hobøl	3.7
Vestby	2
Ski	5.8
Frogn	4.7
Nesodden	5.4
Oppegård	3.2
Bærum	37.61
Asker	15.38
Rælingen	7.64
Lørenskog	4.12
Skedsmo	18.03
Nittedal	1.04
Ullensaker	4.3
Nannestad	2.75
Oslo	198.86
Kongsvinger	2.28
Hamar	13.7
Ringsaker	3.2
Løten	0.2
Elverum	6.45
Åmot	0.2
Tynset	2
Lillehammer	8.9
Gjøvik	7.4
Sør-Fron	0.4
Østre Toten	0.5
Vestre Toten	0.2
Jevnaker	1

Lunner	1
Gran	0.75
Drammen	15.4
Kongsberg	7.1
Ringerike	2.5
Nes	0.8
Modum	1
Øvre Eiker	0.8
Horten	3.2
Holmestrand	1.2
Tønsberg	16.13
Sandefjord	9.2
Larvik	6.15
Stokke	0.2
Lardal	1
Porsgrunn	6.6
Skien	8.29
Notodden	2.6
Bamble	0.2
Kragerø	0.2
Tinn	0.2
Hjartdal	1
Seljord	0.8
Tokke	0.4
Risør	1.4
Grimstad	0.62
Arendal	1
Tvedestrand	0.5
Froland	8.8
Kristiansand	22.97
Mandal	1
Farsund	1
Flekkefjord	1
Songdalen	2.3
Søgne	0.2
Eigersund	2.2
Sandnes	8
Stavanger	19.3
Haugesund	12.7
Time	1.2
Sola	1.2
Randaberg	2.6
Strand	0.5
Sauda	1
Kvitsøy	0.2

Bergen	46.36
Etne	1
Bømlo	0.2
Stord	3.9
Kvinnherad	1.2
Odda	1
Eidfjord	1
Voss	3.2
Kvam	0.5
Os	14.45
Fjell	7
Flora	2
Lærdal	0.84
Fjaler	0.2
Førde	1.2
Naustdal	1
Molde	2.2
Ålesund	6.5
Kristiansund	2.2
Volda	0.2
Rindal	1
Trondheim	31.25
Rissa	0.3
Oppdal	1.4
Røros	1.27
Midtre Gauldal	0.2
Steinkjer	1.4
Namsos	3
Stjørdal	1.2
Levanger	7.5
Bodø	13.45
Narvik	2.85
Sømna	0.75
Alstahaug	0.2
Vefsn	0.32
Rana	1.575
Fauske	0.8
Vestvågøy	0.2
Hadsel	0.2
Øksnes	1.6
Sortland	1
Tromsø	14.2
Kvæfjord	1
Bjarkøy	0.2
Alta	3.2

Porsanger Porsángu Porsanki	1
Kárásjohka Karasjok	1.2

Appendix D

Evaluating the performance of the logistic model

Log Likelihood Ratio Test

Private Specialists Visit

	Model 1*	Model 2	Model 3**
Initial -2 log. Likelihood	6001.976		
-2 log Likelihood	5906.032	5791.038	5780.292
Reduction in -2log likelihood	95.944	114.994	10.746
Degrees of Freedom (The additional DF)	4	7	3
Critical value at 5% level	9.4877	14.067	7.8147
H0: The new model does not fit our data better	REJECT	REJECT	REJECT
McFaddens statistic	0.015985402	0.035144759	0.036935169

	Model 1*	Model 2	Model 4**
Initial -2 log. Likelihood	6088.341		
-2 log Likelihood	5992.435	5871.222	5819.53
Reduction in -2 log likelihood	95.906	121.213	51.692
Degrees of Freedom (The additional DF)	4	7	2
Critical value at 5% level	9.4877	14.067	5.9915
H0: The new model does not fit our data better	REJECT	REJECT	REJECT
McFaddens statistic	0.015752403	0.035661439	0.044151765

***Model 1 are being compared with a model consisting of a constant term only.**

****Model 3 and 4 are both being compared agaist model 2, since the test requires nested models.**

Log Likelihood Ratio Test

Hospital Inpatient Stay

	Model 1*	Model 2	Model 3**
Initial -2 log. Likelihood	4003.096		
-2 log Likelihood	3853.567	3815.138	3809.56
Reduction in -2 log likelihood	149.529	38.429	5.578
Degrees of Freedom (The additional DF)	4	7	3
Critical value at 5% level	9.4877	14.067	7.8147
H0: The new model does not fit our data better	REJECT	REJECT	FAIL TO REJECT
McFaddens statistic	0.037353339	0.046953158	0.04834658

	Model 1*	Model 2	Model 4**
Initial -2 log. Likelihood	4054.358		
-2 log Likelihood	3900.604	3862.103	3856.544
Reduction in -2 log likelihood	153.754	38.502	5.559
Degrees of Freedom (The additional DF)	4	7	2
Critical value at 5% level	9.4877	14.067	5.9915
H0: The new model does not fit our data better	REJECT	REJECT	FAIL TO REJECT
Macfaddens statistic	0.037923143	0.047419591	0.048790709

***Model 1 are being compared with a model consisting of a constant term only.**

****Model 3 and 4 are both being compared agaist model 2, since the test requires nested models.**

Hospital Outpatient Visit			
	Model 1*	**Model 2**	**Model 3****
Initial -2 log. Likelihood	7019.982		
-2 log Likelihood	6583.913	6545.237	6540.344
Reduction in -2 log likelihood	43.,069	38.676	4.893
Degrees of Freedom (The additional DF)	4	7	3
Critical value at 5% level	9.4877	14.067	7.8147
H0: The new model does not fit our data better	REJECT	REJECT	FAIL TO REJECT
McFaddens statistic	0.06211825	0.067627666	0.068324677

	Model 1*	**Model 2**	**Model 4****
Initial -2 log. Likelihood	7115.9		
-2 log Likelihood	6670.559	6628	6613.726
Reduction in -2 log likelihood	445.341	38.502	14.274
Degrees of Freedom (The additional DF)	4	7	2
Critical value at 5% level	9.4877	14.067	5.9915
H0: The new model does not fit our data better	REJECT	REJECT	REJECT
Macfaddens statistic	0.062583932	0.067994632	0.070000562

***Model 1 are being compared with a model consisting of a constant term only.**

****Model 3 and 4 are both being compared agaist model 2, since the test requires nested models.**